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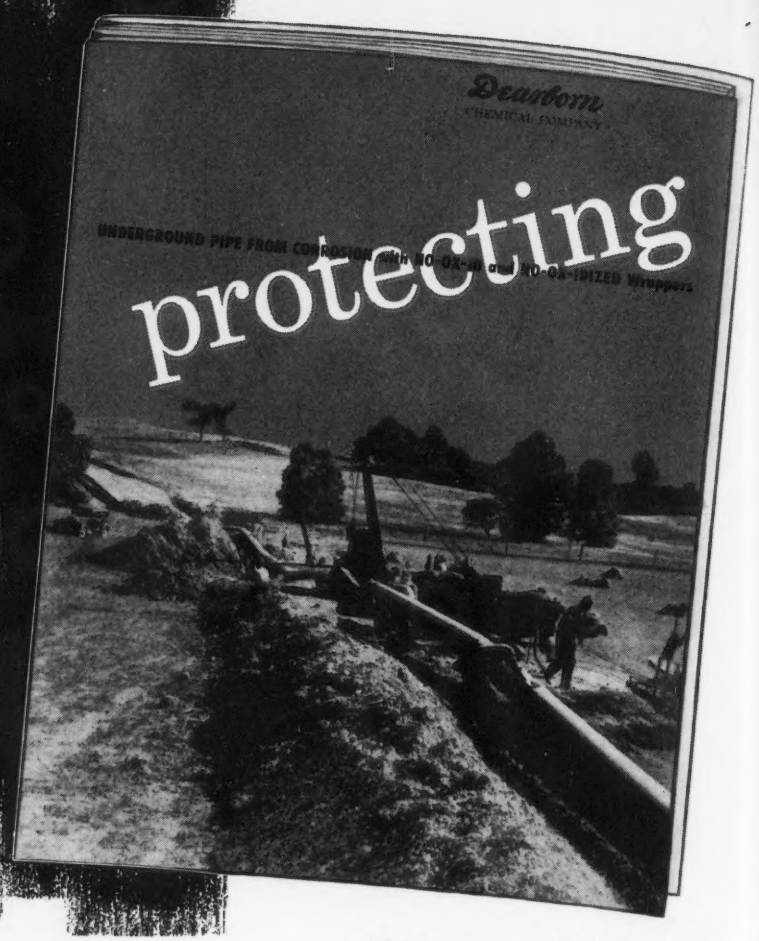

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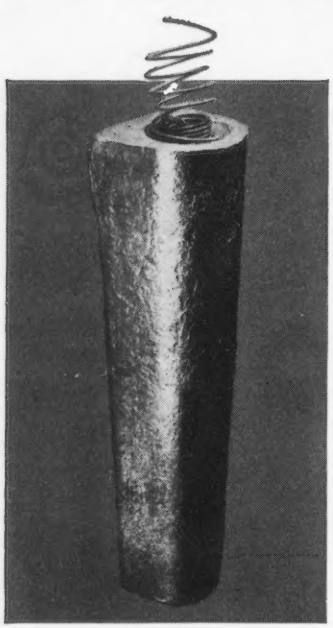

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Dicyclohexylammonium Nitrite, A Volatile Corrosion Inhibitor for Corrosion Preventive Packaging.
By A. Wachter, T. Skei and N. Stillman

Prevention of Corrosion and Metal Attack in the Steam Water Cycle of the Steam Power Plant.
By Frederick G. Straub and Harry D. Ongman

Corrosion Problems in Rural Power Distribution.
By Orville W. Zastrow

Corrosion Problems of Motor Coaches.
By K. L. Raymond

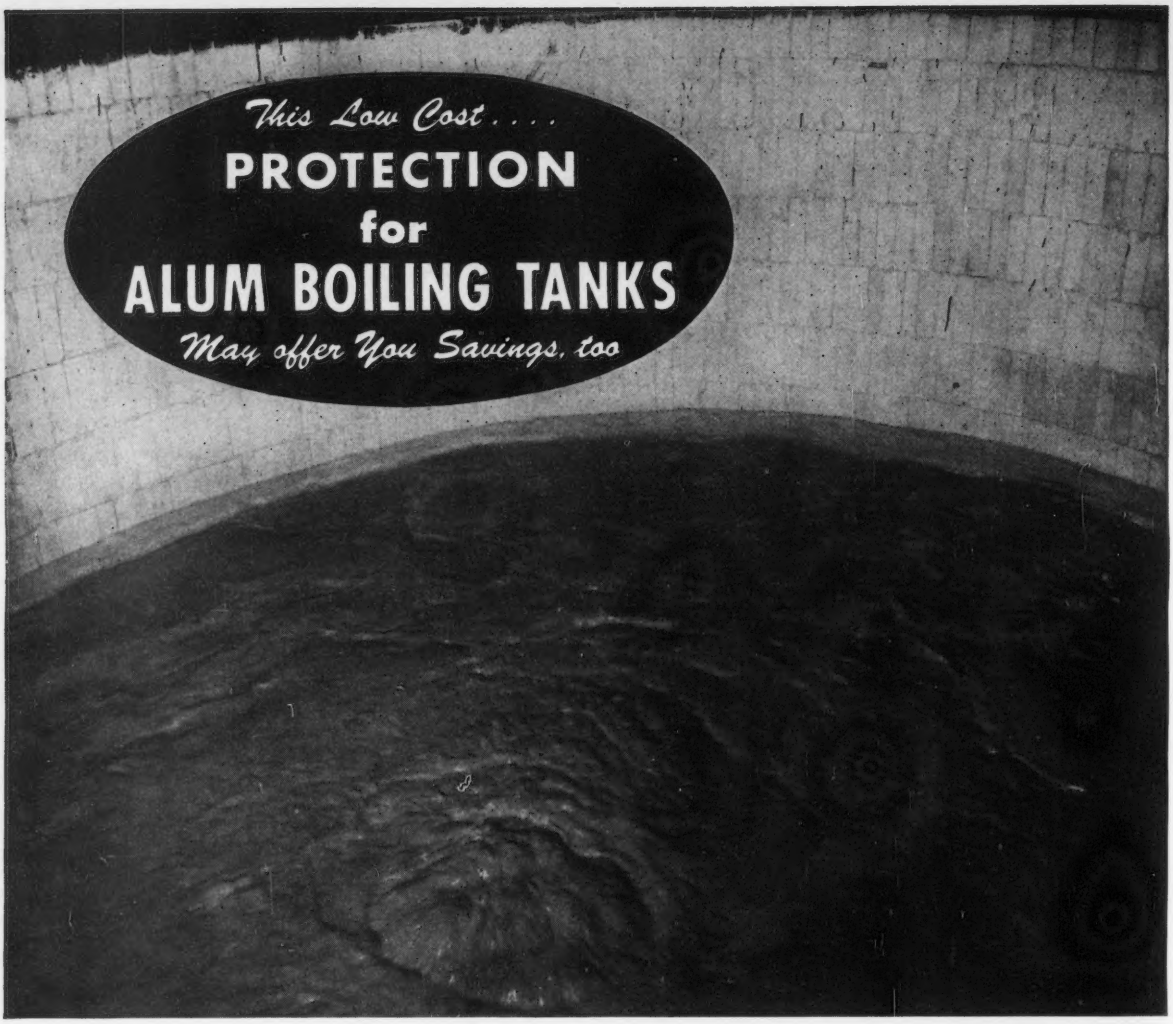
OCTOBER:

Filamentary Growths on Metal Surfaces—"Whiskers".
By K. G. Compton, A. Mendizza and S. M. Arnold.

Passivating Characteristics of the Stainless Steels
By W. G. Renshaw and J. A. Ferree

Economics of Rectifier Installations for Cathodic Protection of a Bare Pipe Line
By D. C. Glass

Stress Corrosion Cracking in Alkaline Solutions—TP5C Report.
By H. W. Schmidt, P. J. Gegner, G. Heineman, C. F. Pogacar and E. H. Wyche.



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TP-5C Sub-Surface Corrosion by Alkaline Solutions. H. W. Schmidt, Chairman, The Dow Chemical Company, 1313 Helen Street, Midland, Mich.

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TP-6E Protective Coatings in Petroleum Production. (Chairman not appointed).

TP-6F Protective Coatings in the Food Industry. G. W. Seagren, Chairman. The Mellon Institute, Pittsburgh, Pa.

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TP-6I Metallic Coatings. (Chairman not appointed).

TP-6J Standards. G. G. Sward, Chairman.

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TP-16A Stray Railway Current Electrolysis. M. D. Fletcher, Chairman, Illinois Bell Telephone Co., 212 West Randolph St., Chicago 6, Ill. J. Svetlik, Co-chairman, Northern Indiana Public Service Co., 5265 Hohman Ave., Hammond, Ind.

TP-16B Corrosion of Lead and Other Metallic Sheaths. B. B. Reinitz, Chairman, The Okonite-Callender Cable Co., Inc., 730 Twenty-first St., Paterson, N. J. T. J. Maitland, Co-chairman, American Telephone & Telegraph Co., 32 Sixth Ave., New York 13, N. Y.

TP-16C Cathodic Protection of Cable Sheaths. W. J. Schreiner, Chairman, Cincinnati Gas & Electric Co., Cincinnati 2, Ohio. R. M. Lawall, Co-chairman, American Telephone & Telegraph Co., 1538 Union Commerce Bldg., Cleveland 14, Ohio.

TP-16D Tests and Surveys. L. J. Gorman, Chairman, Robin Beach Engineers Associated, 32 Court St., Brooklyn 2, N. Y. Frank E. Kulman, Co-chairman, Consolidated Edison Co. of New York, 4 Irving Place, New York 3, N. Y.

TP-16E Corrosion and Protection of Pipe-Type Cables. Frank Kahn, Chairman, Philadelphia Electric Co., 2301 Market St., Philadelphia 3, Pa.

TP-16F Non-Metallic Sheath Coatings. Geo. H. Hunt, Chairman, Simplex Wire & Cable Co., 79 Sidney St., Cambridge 39, Mass.

TP-17 STANDARDIZATION OF PROCEDURES FOR MEASURING PIPE COATING CONDUCTANCE

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TP-18 INTERNAL CORROSION OF FACILITIES FOR STORAGE AND TRANSPORTATION OF PETROLEUM

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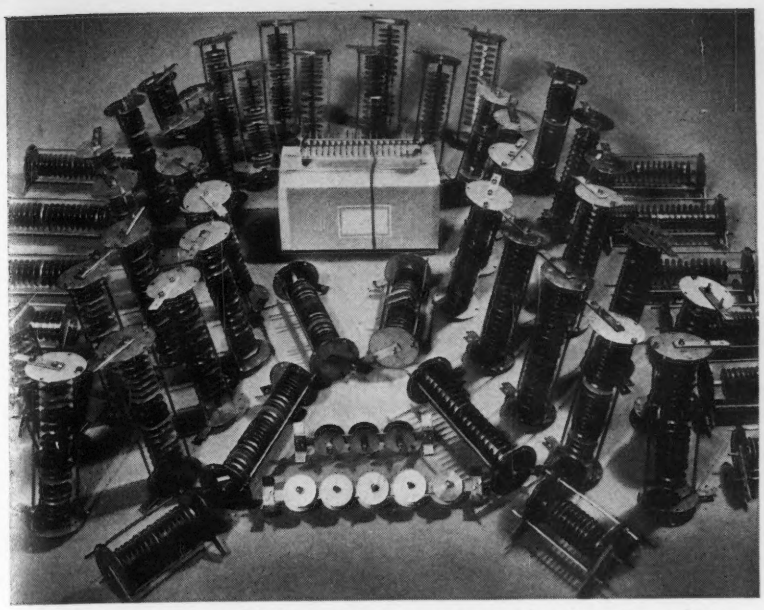
Houston, Texas



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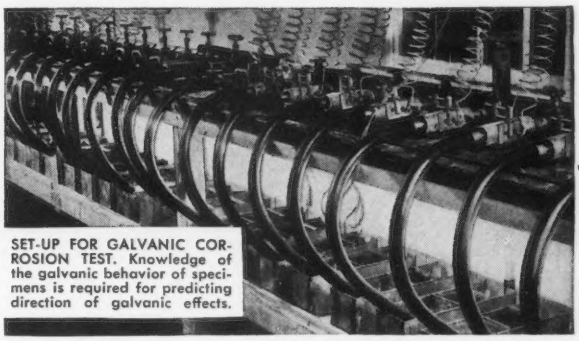

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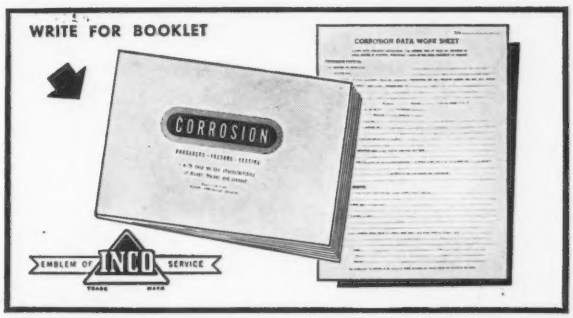

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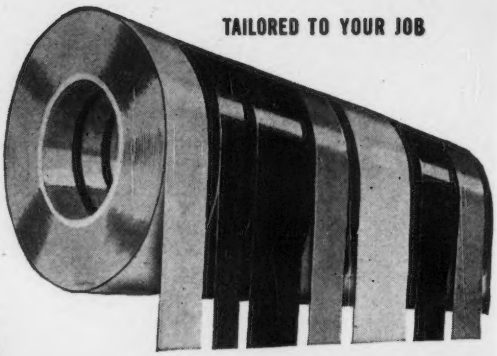

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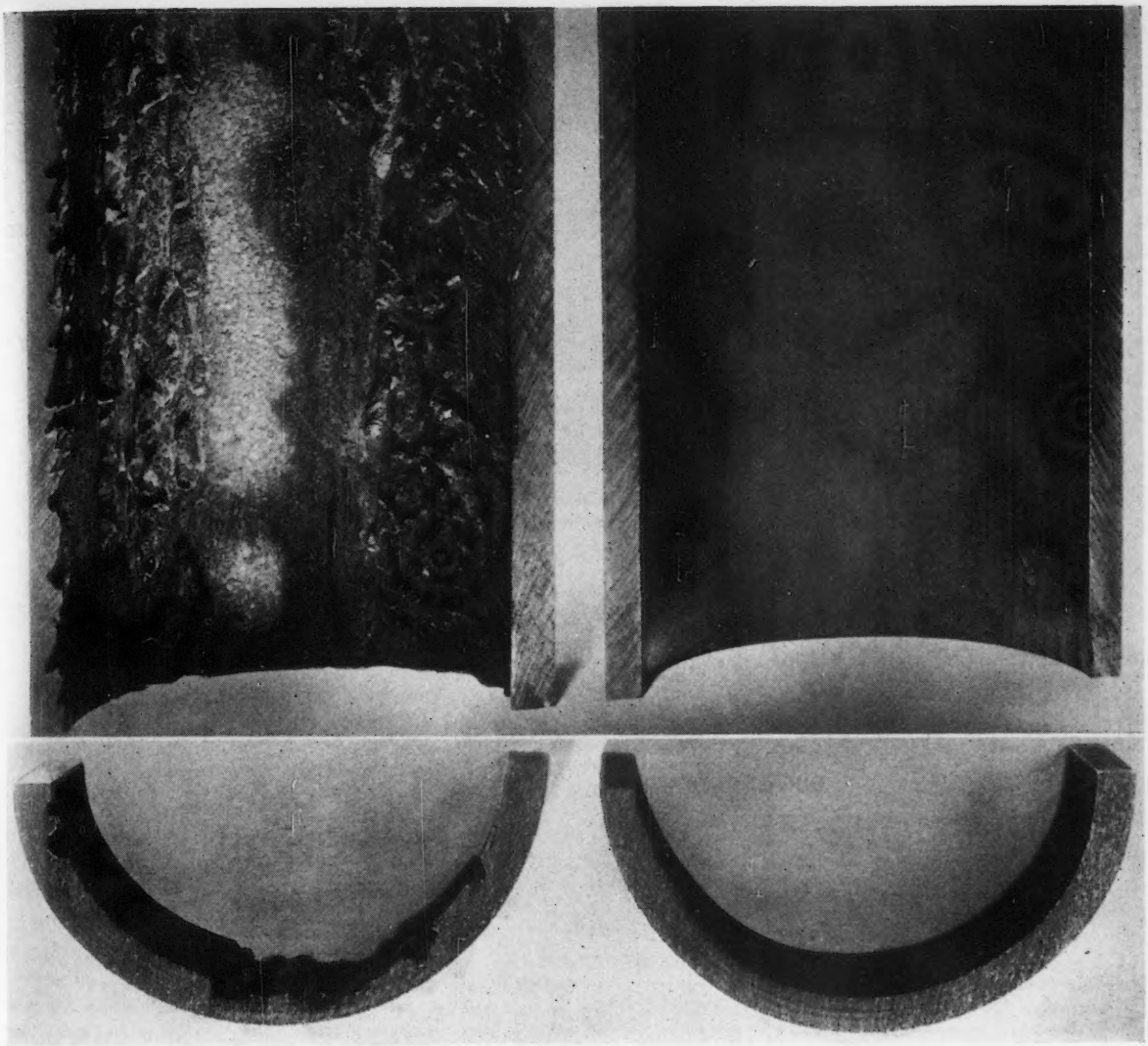
***Polyken* Industrial Tape, Department of Bauer & Black, Division of The Kendall Company**



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is a non-profit, scientific and research association of individuals and companies concerned with corrosion or interested in it, whose objects are:

(a) To promote the prevention of corrosion, thereby curtailing economic waste and conserving natural resources.

(b) To provide forums and media through which experiences with corrosion and its prevention may be reported, discussed and published for the common good.

(c) To encourage special study and research to determine the fundamental causes of corrosion, and to develop new or improved techniques for its prevention.

(d) To correlate study and research on corrosion problems among technical associations to reduce duplication and increase efficiency.

(e) To promote standardization of terminology, techniques, equipment and design in corrosion control.

(f) To contribute to industrial and public safety by promoting the prevention of corrosion as a cause of accidents.

(g) To foster cooperation between individual operators of metallic plant and structures in the joint solution of common corrosion problems.

(h) To invite a wide diversity of membership, thereby insuring reciprocal benefits between industries and governmental groups as well as between individuals and corporations.

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Vol. 7 August, 1951 No. 8

Objectives of TP-16 Electrolysis and Corrosion of Cable Sheaths

By IRWIN C. DIETZE*

TECHNICAL PRACTICES Committee 16 was born during a meeting of Technical Practices Committee 12—"Effect of Electrical Grounding on Corrosion," at the annual conference of the NACE in St. Louis, 1950. For several years, electrolysis and cable corrosion engineers have been discussing the possibility of forming such a committee. Membership to this committee is open to all representatives from utilities such as: electric, telephone, telegraph, railway, as well as electrolysis committees, cable manufacturers and others interested in the subject.

Scope of Work

The scope of this committee is to collect, investigate and develop data on electrolysis and corrosion of lead and other types of cable sheaths and make this information available to all members concerned with these problems. The committee is divided into six subcommittees who will handle specific projects or problems.

Organization

During the New York meeting, in March 1951, the main committee met and discussed plans for the future, and each of the six subcommittees held individual meetings and outlined plans for the first year's activities. Some of these plans are as follows:

Subcommittee TP-16A—"Electrolysis and Corrosion of Cable Sheaths" has formed three groups to study: 1) cable bonding, bonding to other utilities, and insulating joints, 2) drainage to railway substations and booster drainage, 3) reverse current switches and valve rectifiers. These three groups for their first year's work plan to collect and compile: 1) present practices which are effective and satisfactory, 2) past practices which are unsound and should be avoided, 3) current problems that merit mutual consideration.

Subcommittee TP-16B—"Corrosion of Lead and Other Metallic Sheaths," has formed five groups to investigate and develop technical information: 1) on the process of cathodic protection, 2) on concentration cells which for the purpose of this study are considered as conditions due to differences of environment of the same metal, 3) of galvanic action which, for the purpose of this group, is broadly defined as difference of metals including metallic salts in the same environment, 4) on alternating current corrosion and 5) on corrosion caused by micro-biological action.

Subcommittee TP-16C—"Cathodic Protection of Cable Sheaths" has formed a long-range plan to study: 1) protective criteria and the determination of maximum and minimum allowable potentials and consideration of the avoidance of cathodic corrosion, 2) ground bed or anode location and design and maintenance of the proper distances from cable sheaths, 3) the characteristics, installation and design of galvanic anode systems for use with lead cable sheaths and 4) use of insulating joints and sheath ground cells.

Subcommittee TP-16D—"Tests and Surveys" is planning a questionnaire to determine: 1) types of surveys, a) preliminary, b) routine, c) special, d) duct surveys, e) manhole tests, 2) instruments and equipment, a) types and ranges of instruments, b) test electrodes and 3) interpretation of test data a) classification of severity of condition.

Subcommittee TP-16E—"Corrosion and Protection of Pipe Type Cables" is planning to gather all available data on present installations and experiences so that they can set up some standards to be available to the industry. Their work ties in a great deal with some of the other committees.

Subcommittee TP-16F—"Non-Metallic Sheath Coatings" plans to: 1) compile technical properties of

* Chairman, TP-16—Electrolysis and Corrosion of Cable Sheaths; Department of Water and Power, City of Los Angeles, California.

various non-metallic sheath materials from specifications generally available, 2) search literature for data on resistance of these materials to chemically corrosive media including solvents, d-c electrolysis, bacteria and molds, 3) evaluate cable pulling compounds with respect to their use with non-metallic sheaths and protected lead sheaths.

Current members of these committees are as follows:

Officers of TP-16

Chairman: Irwin C. Dietze, Department of Water and Power of the City of Los Angeles, Box 3669 Terminal Annex, Los Angeles 54, Cal.

Secretary: A. L. Ayres, New Jersey Bell Telephone Co., 281 Washington St., Newark, N. J.

TP-16A—"Stray Railway Current Electrolysis."

Scope: To collect and compile methods of cable bonding, drainage to railway substations, booster drainage, reverse current switches, insulating joints, bonding to other utilities, etc.

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R. I. Perry, Commonwealth Edison Co., 72 W. Adams St., Chicago, Ill.
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J. J. Pokorny, Cleveland Electric Illuminating Co., 75 Public Square, Cleveland, Ohio.
E. C. Rue, Boston Edison Co., 39 Boylston St., Boston 12, Mass.
R. G. Rydell, Electro Rust Proofing Corp., 1229 W. Washington Blvd., Chicago 7, Ill.
D. R. Werner, American Tel. & Tel. Co., 20 N. Wacker Dr., Chicago, Ill.

TP-16B—"Corrosion of Lead and Other Metallic Sheaths."

Scope: To investigate and develop technical information on the causes of corrosion on underground cables such as: stray current electrolysis, a-c electrolysis, galvanic potentials, environment and biological influences.

Chairman: B. B. Reinitz, The Okonite-Callender Cable Co., 730-21st Ave., Paterson, N. J.

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E. R. Stauffacher, Southern California Edison Co., Box 351, Los Angeles 53, Cal.
D. R. Werner, American Tel. & Tel. Co., 20 N. Wacker Dr., Chicago, Ill.

TP-16C—"Cathodic Protection of Cable Sheaths"

Scope: To investigate and develop methods of application of cathodic protection to cable sheaths, including the study of rectifiers, ground beds or anodes, permissible current density, galvanic anodes and sheath grounding cells, and to collaborate with Committee TP-4 "Minimum Current Requirements for Cathodic Protection."

Chairman: W. J. Schreiner, Cincinnati Gas & Electric Co., 323 Plum St., Cincinnati 2, Ohio.

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J. J. Pokorny, Cleveland Elec. Illuminating Co., Cleveland, Ohio.
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J. Svetlik, Indiana Public Service Co., 5265 Hohman Ave., Hammond, Ind.
S. E. Trouard, New Orleans Public Service Inc., New Orleans, La.
H. W. Wahlquist, Ebasco Services, Inc., 2 Rector St., New York 6, N. Y.
R. M. Wainwright, University of Illinois, Urbana, Ill.

TP-16D—"Tests and Surveys"

Scope: To study and develop methods of conducting surveys on cable sheaths; to investigate and recommend the use of various types of electrodes and instruments; development of new instruments especially applicable to cable sheaths. To collaborate with Committee TP-14—"Instruments for Corrosion Measurements," and with the A.G.A. Committe on Instruments.

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M. J. H. Buehler, Amer. Tel. & Tel. Co., Bourse Bldg., Philadelphia, Pa.
J. W. Danser, Amer. Tel. & Tel. Co., 195 Broadway, New York 7, N. Y.
H. W. Dieck, Long Island Lighting Co., 250 Old Country Rd., Mineola (L. I.), N. Y.
I. C. Dietze, Dept. of Water & Power, Box 3669 Terminal Annex, Los Angeles 54, Cal.
M. D. Fletcher, Illinois Bell Tel. Co., 215 W. Randolph St., Chicago 6, Ill.
E. M. Griffin, Southern Bell Tel. & Tel. Co., Birmingham, Ala.
Oliver Henderson, Ohio Bell Tel. Co., 750 Huron Rd., Cleveland 5, Ohio.
W. C. Honecker, Indiana Bell Tel. Co., 240 N. Meridian St., Indianapolis, Ind.
L. Horvath, Ohio Bell Tel. Co., 820 W. Superior Ave., Cleveland, Ohio.
J. C. Howell, Public Service Electric and Gas Co., 200 Boyden Ave., Maplewood, N. J.
Frank Kahn, Philadelphia Electric Co., 2301 Market St., Philadelphia 3, Pa.
H. F. Koester, Consolidated Edison Co. of New York, 708 First Ave., New York 17, N. Y.
F. E. Kulman, Consolidated Edison Co. of New York, 4 Irving Place, New York 3, N. Y.
R. M. Lawall, Amer. Tel. & Tel. Co., Cleveland, Ohio.
L. O. McCormick, Consolidated Gas, Electric Light & Power Co. of Baltimore, Baltimore 3, Md.
T. J. Maitland, Amer. Tel. & Tel. Co., 32-6th Ave., New York 13, N. Y.
M. C. Miller, Ebasco Services, Inc., No. 2 Rector St., New York 6, N. Y.
V. J. Payton, Commonwealth Edison Co., 72 W. Adams St., Chicago, Ill.
J. B. Pike, Bell Telephone Laboratories, Murray Hill, N. J.
Robert Pope, R. D. No. 3, Quakertown, Pa.
E. R. Stauffacher, Southern Calif. Edison Co., Box 351, Los Angeles 53, Cal.
J. Svetlik, Indiana Public Service Co., 5265 Hohman Ave., Hammond, Ind.
L. P. Van Houton, Amer. Tel. & Tel. Co., 100 William St., New York, N. Y.
R. M. Wainwright, University of Illinois, Urbana, Ill.
L. L. Whiteneck, Long Beach Harbor Dept., 1333 El Embarcadero, Long Beach, Cal.

TP-16E—"Corrosion and Protection of Pipe Type Cables."

Scope: To study types of coatings, testing methods, grounding and bonding, drainage and cathodic protection. Collaborate with Committee TP-6D—"Protective Pipe Coatings."

Chairman: Frank Kahn, Philadelphia Electric Co., 2301 Market St., Philadelphia 3, Pa.

Members:

H. M. Clayton, Memphis Light, Gas and Water Division, Box 388, Memphis, Tenn.
H. W. Dieck, Long Island Lighting Co., 250 Old Country Rd., Mineola (L. I.), N. Y.
I. C. Dietze, Dept. of Water & Power, Box 3669 Terminal Annex, Los Angeles 54, Cal.
J. C. Howell, Public Service Electric and Gas Co., 200 Boyden Ave., Maplewood, N. J.
H. F. Koester, Consolidated Edison Co. of New York, 708 First Ave., New York 17, N. Y.
W. B. MacKenzie, Phelps-Dodge Copper Products Corp., Yonkers Plant, Yonkers 1, N. Y.
P. E. Nichols, Southern Union Gas Co., P. O. Box 238, Galveston, Texas.
B. B. Reinitz, The Okonite-Callender Cable Co., 730-21st Ave., Paterson, N. J.
W. D. Sanderson, The Detroit Edison Co., 2000-2nd Ave., Detroit 26, Mich.
S. E. Trouard, New Orleans Public Service Co., New Orleans 9, La.
H. W. Wahlquist, Ebasco Services, Inc., 2 Rector St., New York 6, N. Y.

TP-16F—"Non-Metallic Sheath Coatings."

Scope: To investigate and compile technical data on non-metallic sheaths for underground cables.

Chairman: George H. Hunt, Simplex Wire and Cable Co., 79 Sidney St., Cambridge 39, Mass.

Members:

A. G. Andrews, Michigan Bell Tel. Co., Detroit 26, Mich.
I. C. Dietze, Dept. of Water & Power, Box 3669 Terminal Annex, Los Angeles 54, Cal.
M. D. Fletcher, Illinois Bell Tel. Co., 215 W. Randolph St., Chicago 6, Ill.
E. M. Griffin, Southern Bell Tel. & Tel. Co., Birmingham, Ala.
Oliver Henderson, Ohio Bell Tel. Co., 700 Prospect Ave., Cleveland, Ohio.
L. Horvath, Ohio Bell Tel. Co., 750 Prospetc Ave., Cleveland, Ohio.
Frank Kahn, Philadelphia Electric Co., 2301 Market St., Philadelphia 3, Pa.
W. B. MacKenzie, The Phelps-Dodge Copper Products Corp., Yonkers Plant, Yonkers, 1, N. Y.
L. O. McCormick, Consolidated Gas Electric Light & Power Co. of Baltimore, Baltimore, Md.
V. B. Pike, Bell Telephone Laboratories, Murray Hill, N. J.
B. B. Reinitz, The Okonite-Callender Cable Co., 730-21st Ave., Paterson, N. J.
W. D. Sanderson, The Detroit Edison Co., 2000-2nd Ave., Detroit 26, Mich.
E. R. Stauffacher, The Southern Calif. Edison Co., Box 351, Los Angeles 53, Cal.
R. B. Stephenson, The Dayton Power & Light Co., Dayton 1, Ohio.
J. Svetlik, Indiana Public Service Co., 5265 Hohman Ave., Hammond, Ind.

Members Not Associated With Any of the Six Sub-Committees:

E. D. Bent, Northern Electric Co., Ltd., 1261 Shearer St., Montreal (Quebec), Canada.
A. S. Brookes, Public Service Electric and Gas Co., 80 Park Place, Newark, N. J.
G. R. Canning, Cleveland Committee on Electrolysis, Ohio Bell Telephone Co., 750 Huron Rd., Cleveland 15, Ohio.
L. J. Davis, Public Service Co. of Northern Illinois, Northbrook, Ill.
I. A. Denison, National Bureau of Standards, Washington 25, D. C.
L. C. Eddy, Public Service Co. of Northern Illinois, Chicago 3, Ill.
R. D. Elliott, Dallas Power & Light, Co., Dallas, Texas.
T. J. Fleming, Associated Telephone Co., Ltd., 1314-7th St., Santa Monica, Cal.
F. W. Funk, Ohio Edison Co., Akron, Ohio.
C. I. Hendricks, Texas Electric Service Co., Ft. Worth, Texas.
D. Hendrickson, East Bay Municipal Utility District, 512-16th St., Oakland 4, Cal.
W. G. Jacobek, Illinois Bell Telephone Co., 641 Elgin Ave., Forest Park, Ill.
R. J. Kuhn, Consulting Engineer, 1643 Octavia St., New Orleans 15, La.
D. M. Lappi, Northern Electric Co., Ltd., 1261 Shearer St., Montreal (Quebec), Canada.
B. C. Lattin, Westchester Lighting Co., 9 S. First Ave., Mount Vernon, N. Y.
R. E. Morse, American Gas & Electric Service Corp., 30 Church St., New York 8, N. Y.
L. M. Plym, Illinois Bell Telephone Co., 208 W. Washington St., Chicago 6, Ill.
R. L. Rayner, Michigan Bell Telephone Co., 1365 Cass Ave., Detroit, Mich.
L. J. Roberts, Southern Public Service Co., Amarillo, Texas.
G. B. Shanklin, General Electric Co., No. 1 River Rd., Schenectady 5, N. Y.
A. M. Spaulding, Technical Committee, Denver, Committee on Electrolysis, The Mountain States Tel. & Tel. Co., Denver, Colo.
D. Spector, Schapira Tyroler & Co., 18 Mikve Israel St., Tel Aviv, Israel.
W. C. White, Louisville Electrolysis Committee, Southern Bell Telephone Co., Hurt Bldg., Atlanta, Ga.
G. T. Williams, Iowa-Illinois Gas and Electric Co., Davenport, Iowa.
L. F. Williams, Joint Committee for the Protection of Underground Structures in the East Bay Cities, 3493 Hollis, Oakland 8, Cal.
L. T. Williams, Southwestern Gas and Electric Co., Shreveport, La.

ERRATUM

A Proposed Standard Method for Measuring the Electrical Resistance of Pipe Line Coatings. By Walter F. Rogers, B. H. Davis, Lyle Sheppard, L. G. Sharpe, E. R. Allen, Donald Bond and P. T. Miller. *Corrosion*, 7, No. 7, 245-251 (1951).

Substitute the equation below for the equation printed on Page 246, Column 2, immediately below Line 13:

$$K = \left(V - \frac{I\rho}{2\pi L} \ln \frac{r_2}{r_1}\right) \frac{L}{I}$$

The correction being that the ratio $\frac{L}{I}$ is substituted for the ratio $\frac{I}{N}$.

High Pressure Sweet Oil Well Corrosion*

By H. L. BILHARTZ

THE PROBLEM of corrosion in high pressure sweet oil wells was first noted in 1945 in Southeastern Louisiana, where several relatively new wells suffered severe attack. At that time only one or two companies were concerned and at most a few dozen wells affected. Slight mention was given this problem by Waldrip[1] in April, 1948. Later, in April, 1950, Buchan[2] discussed the subject at some length. Serious concern was first felt when strings of tubing required replacement after two to four years' service. Companies have reported an average workover cost of $10,000, with a cost of $20,000 not uncommon, and in isolated instances $30,000 to $40,000 have been required to replace tubing. Thus operators were confronted with a serious economic problem. The rather minor experiences heretofore noted were climaxed in 1948 when a well in the Bayou Sale Field blew out as a result of corrosion. Not only was the initial cost of controlling the well high, but ultimately the well itself was lost. Thus a 10,000 foot well drilled in marshy land was prematurely abandoned after two years' production. The monetary loss resulting from that single failure was approximately $150,000. Subsequently, as a direct result of this experience, one-half million dollars were spent on workover and remedial measures by one company in this field.

The evidence presented by an ever increasing number of tubing failures gave managements of various companies justification to undertake extensive study of the problem. Individual company engineers undertook private investigations. In addition, cooperative efforts among engineers of several companies introduced historical data which were necessary during early stages of investigation. Subsequently, National Association of Corrosion Engineers Technical Practices Committee 1-C on "Sweet Oil Well Corrosion" undertook the problem as its major project for study.

Earlier Study Is Paralleled

Before proceeding with a discussion of the problem, it might be well to compare it with another which confronted the petroleum industry in the early 1940's, namely, that of high pressure condensate well corrosion. Not only is the type of attack experienced in oil wells very similar to that noted in the condensate well study, but the coordinated approach to the problem by individuals, companies and various organizations followed closely the precedent set by the study of condensate well corrosion.

That a serious corrosion problem existed in condensate wells was first recognized in 1943 and discussed in the literature by Brown and Bacon[3] in April of that year. The Natural Gasoline Association of America sponsored a committee called the "Condensate Well Corrosion Research Committee." The purpose was to study the problem, determine its causes, and, more particularly, to find economic remedial measures. Shortly thereafter, a committee on the same subject was sponsored by the Na-

HARRELL L. BILHARTZ, chemical engineer in charge of field problems and material evaluation in the Production Department of The Atlantic Refining Company, Dallas, Texas, received undergraduate training at Southwestern University and graduate training at Harvard and Massachusetts Institute of Technology. He served three years in the Navy during World War II. Mr. Bilhartz is active in committee activities of the Natural Gasoline Association of America and National Association of Corrosion Engineers. He currently is chairman of NACE Committee TP-1C and vice-chairman of committee TP-1.

Abstract

Severe tubing corrosion was recently encountered in high pressure sweet oil wells which were thought by all previously established criteria of judgment to be normal, non-corrosive installations. The evidence presented by an ever-increasing number of tubing failures provided sufficient justification for extensive study of the problem. Individual companies began private investigations. In addition, cooperative efforts among engineers of several companies introduced historical data necessary during early phases of investigation. Subsequently, the National Association of Corrosion Engineers' Corrosion Committee TP-1C undertook the problem as its major project for study. This paper presents the results of statistical studies conducted under the auspices of the NACE committee, as well as basic data established during individual company investigations.

General pitting-type corrosion resulting from carbon dioxide, organic acids and possibly other unidentified corrosive agents occurs frequently in wells producing pipe line oil. The attack continues after wells begin producing water.

Pitting frequency varies with deviations in wall thickness of the tubing. Maximum concentration occurs at points of minimum wall thickness.

Unique and unexplained scale conditions have been observed which obscure the interpretation of tubing caliper surveys. Other popular criteria of corrosion are also difficult of interpretation.

Most known remedial measures have been tried. Inhibitors have proved unsuccessful; galvanizing has been of no value; thermosetting plastic coated tubing, with exceptions, has been promising. Nine percent nickel alloyed steel seems to afford a solution where workover costs are exceptionally high. Nickel plated steel although as yet untried in the field, theoretically seems to offer advantages.

An economic analysis indicates ample justification for further study. It is shown by specific calculation that $1,500,000 must be spent within the next four years because of corrosion in 150 wells concentrated in a small geographic area located in Southeastern Louisiana.

* A paper presented at the Seventh Annual Conference and Exhibition, National Association of Corrosion Engineers, New York, N. Y., March 13-16, 1951.

tional Association of Corrosion Engineers. Headed by Walter Rogers of Gulf Oil, this committee, concerned itself with research toward the causes and prevention of condensate well corrosion. During the early phases of study, activities were directed toward finding a suitable alloy that might be used as a tubing material in condensate wells.

In addition to the committee work mentioned, the problem was studied by engineers of individual companies. The magnitude of the problem soon made it mandatory that cooperative efforts among companies be utilized. Thus was initiated the first intensive cooperative effort among technical men of major oil companies on the general problem of corrosion. This cooperation later led to tremendous advances toward the solution of the gas condensate problem.

The following discussion of high pressure sweet oil well corrosion confirms again the technological advances possible through cooperation of engineers in the petroleum industry.

Questionnaire Is Circulated

In order to develop definitive data, the NACE committee on "Sweet Oil Well Corrosion" felt that a questionnaire containing a general outline of the problem and questions of statistical and technical nature should be distributed to all members of Technical Practices Committee 1. This questionnaire was intended to provide data relative to several variables with respect to corrosion. The variables included age of wells, oil production, water production, paraffin problems, emulsion problems, sand production, bottom hole pressure, bottom hole temperature, surface tubing pressure, gas-oil ratio, depth, and others. In addition, information pertaining to water analysis, gas analysis and other laboratory data relative to the project were requested.

Before presentation of these statistical data, however, pertinent factors relative to type of attack and causative agents will be presented in an effort to establish criteria of corrosiveness necessary to successfully solve the problem.

General pitting corrosion (Figure 1) similar to that encountered in condensate wells was observed. Pitting frequencies were reported to be approximately 75 pits per linear foot of tubing, very often equally distributed throughout an entire joint. The pits were typical of carbon dioxide attack. The intensity of corrosion within a single field was noted to vary greatly. Holes, in rare instances, developed in less than one year. On the other hand, eight or ten years of satisfactory service was recorded for some offset wells. In general, an average tubing life of three to four years might be expected in these areas. Ringworm corrosion (Figure 2) was shown to be isolated. However, where encountered it resulted in considerable trouble during workover operations.

Scale Divided Into Two Categories

Unique scaling conditions (Figure 2) have been observed and considerable work on this phenomenon has been undertaken by several cooperating companies. The types of scale may be divided into two categories:

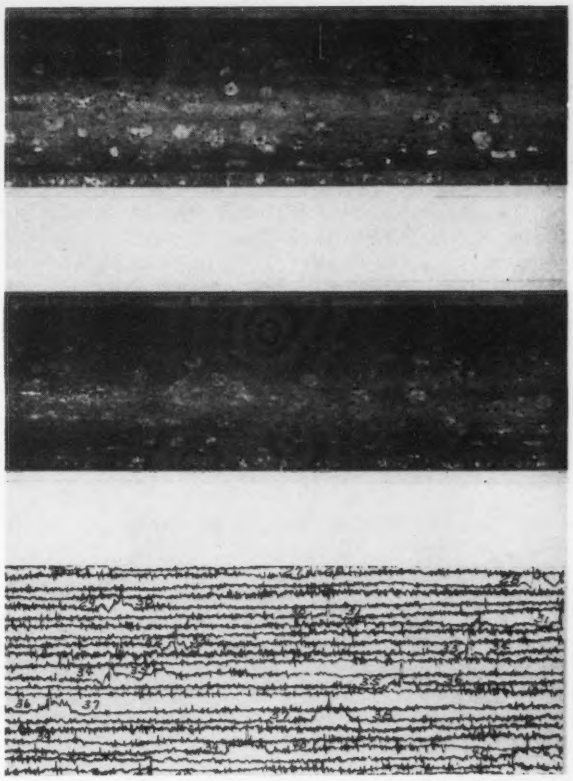

Figure 1—Typical attack.

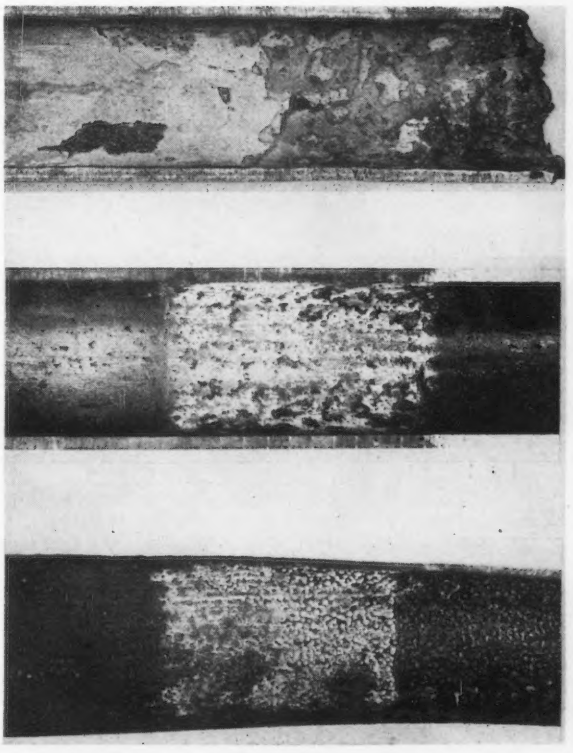

Figure 2—Typical scale formation.

1) thick, heavy, white cement-like solid material, which proved to be barium sulfate and
2) a red oxide-type coating over a thin barium sulfate deposit.

The red "over coating" was "honey-combed" in appearance and extremely hard. A satisfactory explanation of the formation of this type deposit has not been developed. Somewhat similar sulfate deposits have been known to occur in West Texas and other areas when waters containing soluble sulfates and soluble calcium or barium salts are intermingled. However, such a condition has never been reported where little or no water is produced. The significance of this phenomenon assumed major importance and became of more than academic interest when it was realized that such deposits filled many deep pits in the steel tubing, thus rendering tubing caliper surveys, as they are known today, difficult of interpretation.

600 Feet of Tubing Examined

Detailed laboratory experiments were conducted on some 600 feet of tubing taken from a well in the Bayou Sale Field. Field caliper surveys were made by all caliper companies available at the time, under both in-hole and surface conditions. The 600 feet were subsequently sent to the laboratory where they were sawed longitudinally and examined. Hand micrometer measurements were made to determine the deepest penetration per foot, and the number of pits per foot were counted for each foot of the 600 feet. In addition, for three feet within a joint, one at each upset and one in the middle, similar measurements were made for each inch of pipe. It was from these data that the aforementioned figure of 75 pits per linear foot was taken. These experiments were first conducted in detail on tubing as received from the field with the noted barium sulfate and red oxide-appearing scales in place. Subsequently, portions of this pipe were cleaned of scale and again hand micrometer tests made. Pits as deep as 32 percent of wall thickness were revealed that had not previously been visible, and some other pits increased in perceptible depth from 21 percent to 38 percent of the total wall thickness. It was noted (Figure 3) that,

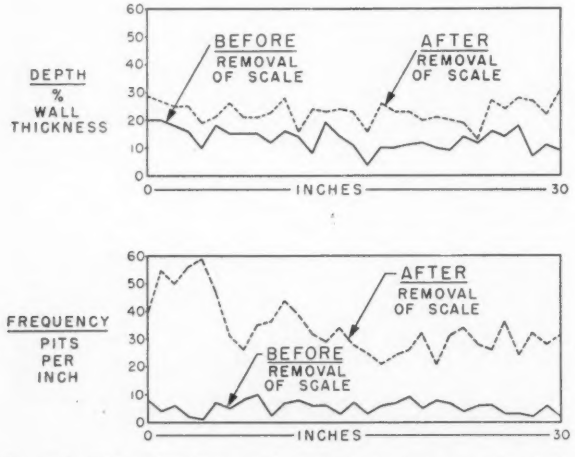

Figure 3—Effect of scale removal on visual pit frequency and depth.

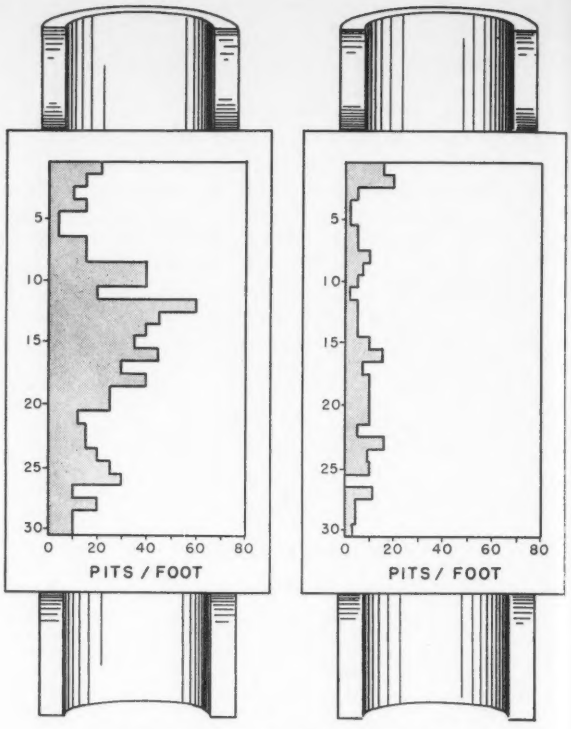

Figure 4—Typical pit distribution within a joint of tubing.

upon scale removal, the pitting frequency per foot increased tenfold in many instances.

No consideration was given to the point of cut when the pipe was initially split; however, upon detailed examination it was found that the majority of pits were included in one longitudinal "half-section" of the joint. This is best illustrated by Figure 4. It may be seen that one "half-section" contains three times the number of pits counted in the corresponding section.

Pits Concentrated at Thin Areas

Figure 5 illustrates the relationship between pit concentration and wall thickness of the tubing. A comparison of both pit frequencies and wall thickness is given for two longitudinal "half-sections" of a 30-foot joint of tubing. It may be seen that, for one "half-section," there is little variation of either factor. By contrast, an examination of the remaining "half-section" reveals a marked variation in wall thickness along the length of pipe. As the wall thickness decreases in the center portion, there may be noted a corresponding increase in pit frequency. The API nominal and minimum wall thickness values are plotted as reference points. It is of interest to note that the nominal value was often exceeded, whereas the measured wall thickness was in all cases greater than the required minimum. It is apparent that, in general, the greatest pit concentration occurs where the wall thickness falls below 0.185 inch.

A graph (not shown) relating the variation of pit depth versus wall thickness did not indicate the same trend, rather the penetration depth pursued a random course along the length of pipe.

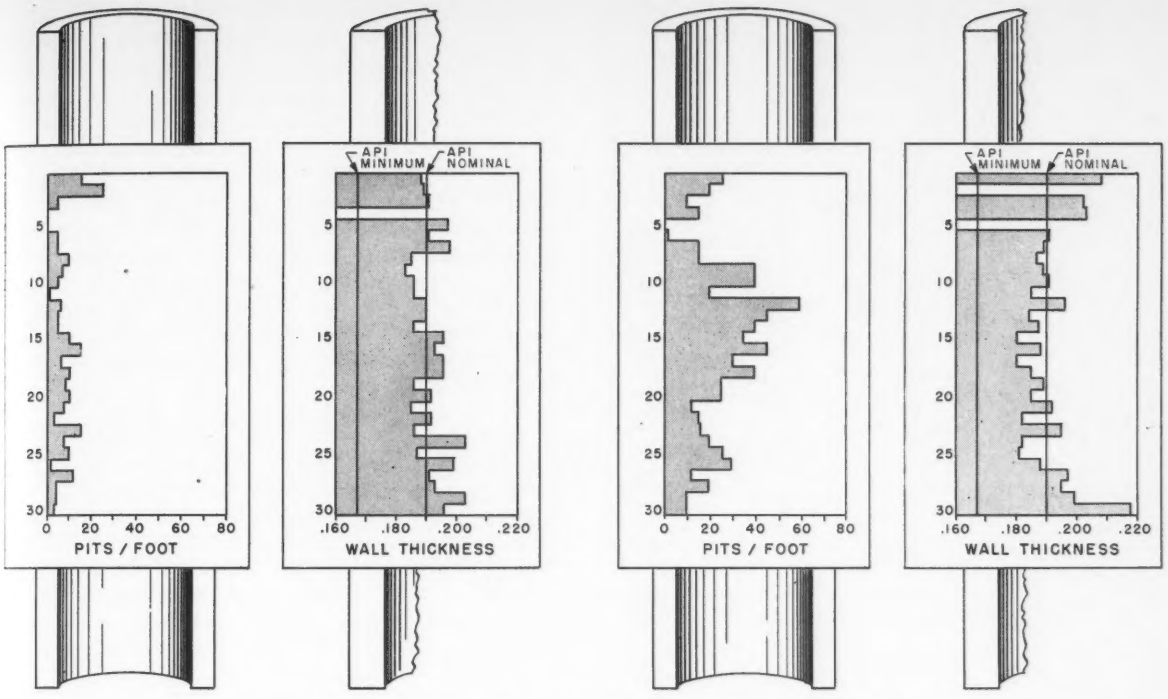

Figure 5—Relation between pit frequency and tubing wall thickness. 30-foot joint.

A possible explanation of the variation in pit concentration as related to wall thickness may be that internal strains are set up in the thinner sections that are not removed in normal heat treatment. In such case, these areas are most susceptible to attack.

Water analyses are always important in an investigation of corrosion problems. It is difficult to illustrate a typical water analysis because waters in the various producing formations where corrosion of this type has been noted vary a great deal; however, Table I presents a typical water from a single field, namely Bayou Sale in Southeastern Louisiana.

Carbon Dioxide a Prime Factor

Gas analyses conducted both in the laboratory and on location have been made by many operators. A carbon dioxide content ranging between 0.5 and 1.2 volumetric percentages was found to exist throughout the general areas involved. As will be shown later, corrosion intensity is greater in wells producing larger quantities of carbon dioxide.

A consideration of paraffin problems existing in the affected areas relative to their effect on corrosion disclosed interesting data. Unusual results were obtained in this phase of study, but no conclusive data are yet available. For example, it was found that upon a lengthy exposure in flow lines, mild steel coupons became coated with copious quantities of paraffin. If this paraffin were cleaned from the coupon at the time of its removal from the flow line, there was no apparent attack on the metal. However, if a portion of the paraffin was left intact for several weeks, it was observed that attack occurred in the area beneath the paraffin deposit. The reaction was not severe enough to cause pitting, but a metal discoloration obviously due to attack on the metal became readily apparent. Aqueous extracts of paraffin taken from the wells, as well as aqueous extracts of produced oil, have shown a pH range of 4.5 to 7. The acidic nature of these extracts has not been satisfactorily explained, and it is quite possible that further efforts in this direction may prove interesting.

TABLE I

Total Solids	76,000 ppm
Calcium	15,000 ppm
Magnesium	300 ppm
Sulfate	33 ppm
Chlorides	46,000 ppm
Carbonate	0 ppm
PH	6.5
Specific Gravity	1.05
Resistivity at 68° F.	0.118 ohm meters
Organic Acid as Acetic Acid	1400 ppm

Intense Attack Areas Are Located

Considerable study has been devoted to finding the portion of tubing attacked most by corrosion. Numerous caliper surveys have established that the most intense attack occurs between 2000 and 6000 feet; however, it must be emphasized that although the general intensity of attack is greatest in this area, severe corrosion occurs both at the top and bottom of the hole. Corrosion attack toward the bottom of the string has been observed in the form of occasional pits rather than the general pitting which occurs at shallower depths. Some feel the isolated pits result strictly from metallurgical defects aggravated by the corrosive environment.

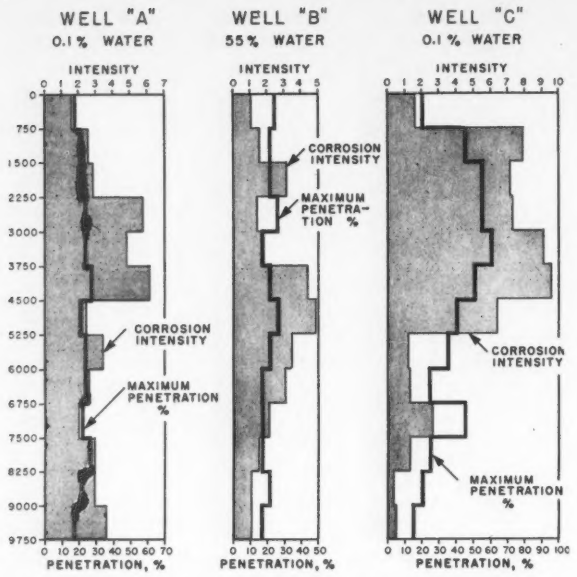

Figure 6—Corrosion intensity related to depth. Note: Corrosion intensity for each depth denotes sum of pit depths for 25 joint sections.

In the case of condensate well corrosion, efforts to hypothesize on the reason for attack in certain portions of the tubing met with some success, primarily because it was possible to determine the area of condensation; however, in the case of oil wells, such an argument is not valid, and to date efforts to explain the phenomenon are not satisfactory. Buchan,[2] in his discussion of the subject, indicated that the top 1000 or 2000 feet of tubing was often protected by paraffin deposition until high water production was encountered. In general, this might be accepted, but there are specific instances where such is not the case. For example, in the Bayou Sale field, where paraffin affords a major problem in itself, severe corrosion was experienced to the surface where pipe line oil was produced. Figure 6 illustrates the intensity of attack over wide portions of the tubing.

When considering the criteria of corrosiveness for high pressure sweet oil wells, reference may again be made to the older problem of gas condensate corrosion. Rogers[4] referred to the criteria of corrosion with respect to condensate work in this manner, "Having a condensate well, how does one know whether corrosion is occurring?" Mr. Rogers stated that in the early stages of condensate well corrosion investigation, this was indeed a good question as the answer was not readily apparent. Corrosion in the past had occurred primarily only in pumping wells producing large quantities of water. Any corrosion which occurred in such a well became readily apparent because of broken rods or penetration of the tubing, causing the well to go off production. Flowing wells did not however, give such an indication of attack until a leak occurred, at which time the damage was extensive and the repairs costly. With extensive study there were developed several criteria of corrosiveness for condensate wells. For example, the iron content of effluent water became an excellent index of corrosion. Organic acids were isolated, and their presence was thought to affect the rate of corrosion.[5] Carbon dioxide was found to be an active corrosive agent and its presence in appreciable quantities was thought indicative of a potentially corrosive environment. Surface coupon tests became popular and it was possible to determine in this manner whether or not the effluent stream at the point at which the coupons were placed was corrosive. Finally the caliper survey instrument, a mechanical device that gave a record of pits in the tubing with the pipe still in place, was developed. All of these methods had their limitations but, when combined, afforded evidence of a corrosive or a non-corrosive environment.

Value of Criteria Is Weighed

With the advent of high pressure sweet oil well corrosion and with the observed similarity of the two types of attack, it was at first assumed that these same criteria of judgment might be applied to the new problem. However, let us look at them individually and see if such is the case.

Iron contents have been determined for several hundred water samples taken from wells known to be corrosive. In many instances a value low enough to be considered negligible by all previously established criteria were found. In addition, wells proved severely corrosive that produced little or no water. The difficulty of obtaining representative "shake out" water samples from installations such as these is readily apparent.

Figure 7 presents the results of water analyses taken from four corrosive wells in the Bayou Sale field. Represented in the graphs are the four following conditions.

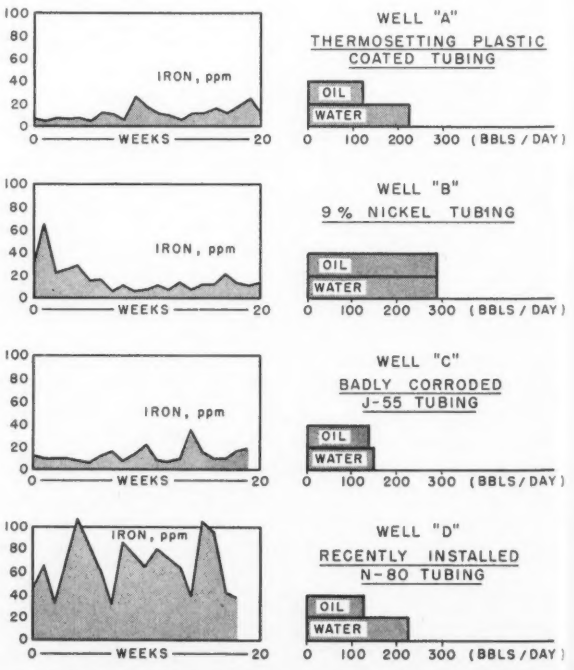

Figure 7—Weekly water analysis—twenty weeks' iron content.

1) a well in which the J-55 tubing is badly corroded and must be replaced within 6 months,
2) a well containing 9 percent nickel tubing,
3) a well containing thermosetting plastic coated tubing, and
4) a well containing recently installed N-80 tubing.

It may be noted that the iron contents of the waters taken from three locations, namely, 9 percent nickel, the thermosetting plastic, and the badly corroded J-55 installations, are all very low by comparison with previously established criteria for corrosive wells. The fourth or recently installed N-80 location, on the other hand, discloses a high iron content. From this one might be led to conclude that N-80 is more susceptible to attack than J-55; however, with the limited data available such a conclusion might be misleading. Considerably more information will be required before a decision on this aspect can be made. From the above it may be seen that the iron content as the sole index of corrosion has proved of little value in the study of high pressure sweet oil well corrosion.

Two criteria previously established in condensate work, however, have proved significant; namely, organic acid and carbon dioxide content. Extremely high organic acid content was discovered in samples received from corrosive wells; concentrations of 1400 to 1500 ppm acetic acid were not uncommon. As Mr. Buchan[2] stated in his paper on this subject, there appears to be a correlation between carbon dioxide content and the rate of corrosion. Recent data verified this conclusion. Companies reported from .5 to 1.2 volumetric percentages of carbon dioxide; well streams containing the higher values were found to be more corrosive.

The value of caliper surveys in condensate work cannot be overemphasized. It has proved an invaluable tool in the study of that problem; however, as discussed previously, its value in sweet oil well corrosion has been obscured by the unique scaling conditions noted. Thus this important tool must be used with caution. (Figure 8.)

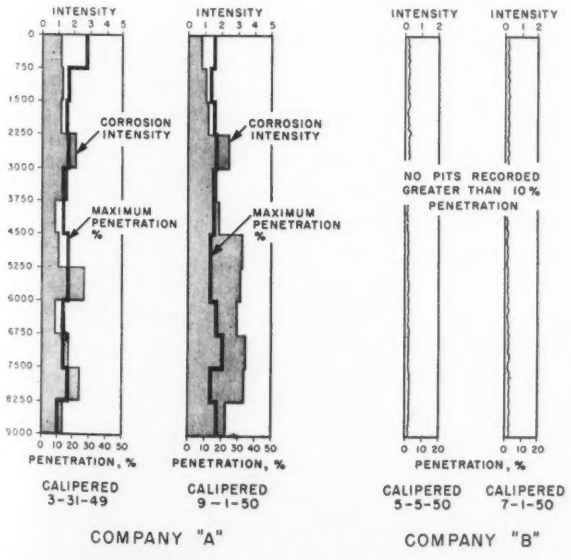

Figure 8—Intensity of corrosion as recorded by caliper surveys made in rapid succession. Note: Corrosion intensity for each depth denotes sum of pit depths for 25 joint sections.

Surface Coupons Are Used

Surface coupon tests which became popular in condensate corrosion work were tried in the study of high pressure sweet oil well corrosion; however, here again, a tool of which much was expected proved of little or no value. Mild steel coupons exposed for periods ranging from 14 days to 8 months displayed no corrosive attack except as related to paraffin formation, even though the wells under test were known to be corrosive.

It may be seen that of the criteria established in condensate work, only two, the organic acid and carbon dioxide content, are of equal importance in this study. A third, the caliper survey, is still important, but must be used with caution. The fourth, or iron content, although affording a possible key to corrosiveness, must be carefully used until better criteria of interpretation are established.

Results of Statistical Survey Conducted By NACE Committee TP-1C

It will be recalled that a statistical questionnaire concerning high pressure sweet oil wells was submitted to all members of NACE Technical Practices Committee 1. Returns of this questionnaire provided data of unusual interest.

Information concerning a total of 359 wells was reported. Of these, approximately 42 percent have indicated tubing corrosion and 20 percent indicated surface equipment corrosion. Figure 9 illustrates the results of the statistical study.

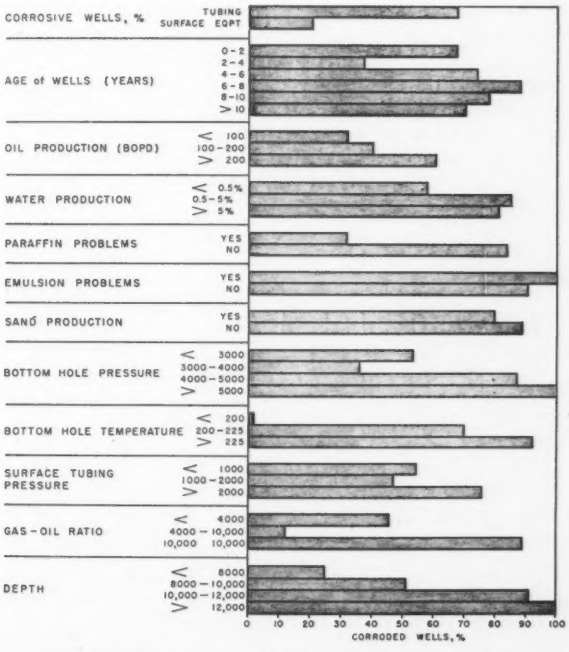

Figure 9—Results of statistical study of corrosion in high pressure sweet oil wells. 359 wells reported to January 25, 1951.

Age of Wells

It may be seen that no apparent correlation exists between the intensity of corrosion and the age of wells. This was not true during the early stages of investigation. In the first presentation of statistical results it was apparent that installations greater than four years of age demonstrated a higher percentage of corrosive wells; however, this trend was offset when more recent data revealed a high percentage of wells less than two years of age to be corrosive. An explanation of this might be that the initial data received represented the wells from fields where failures had necessitated material replacement; whereas, with the advent of emphasis on this particular study, companies began calipering new wells and corrosion was noted during the first year of tubing life. Thus, later questionnaires were more complete, with the result that the overall percentage of corrosive wells was increased for the newer installations.

Oil Production

For statistical purposes, the wells within the defined category were divided into three groups, based on oil production:

1) those producing less than 100 BPD,
2) those producing between 100 and 200 BPD, and
3) those producing greater than 200 BPD.

It may be seen that the percentage of corrosive wells increases proportionately with oil production.

Water Production Investigated

For statistical purposes, water production was also divided into three categories:

1) those wells producing less than ½ of 1 percent water or pipe line oil,
2) those producing between ½ and 5 percent water, and
3) those producing greater than 5 percent water.

It may be seen that there is little or no correlation between the percentage of corrosive wells and water production. This was to be expected, since, as reported previously, severe corrosion was encountered in wells producing pipe line oil. This single factor proves high pressure sweet oil well corrosion to be a unique problem. Never before has corrosion of this nature been experienced where water is not produced in significant quantities.

Sand Cutting

Because sand cutting and corrosion are often confused in reporting observations, it was felt that the production of sand should be included as a variable in the statistical questionnaire. It may be seen that there is no correlation between the percentage of corrosive wells and the presence or absence of sand production.

Paraffin Attack

It will be recalled that unusual attack on metal coupons appeared to be dependent upon paraffin. In view of this fact, it was felt that paraffin conditions should be considered. However, it may be seen that statistically there is little correlation between the percentage of corrosive wells and the presence or absence of paraffin.

Emulsion Problem Not Indicative

Emulsion problems also provided a variable for investigation. Here again, there was little or no correlation between the wells producing fluids which caused emulsion problems and those that did not. This brings up a point that should be discussed to avoid confusion in interpreting these statistical data. It may be seen on the bar graph illustrating emulsion problems that 100 percent of the wells showing emulsion problems were corrosive and that 90 percent of those not creating emulsion problems were similarly so. The explanation of such high percentages for both conditions is that many companies were not able to indicate on their returned questionnaire whether or not emulsions were prevalent. Thus, information relative to this aspect was available on only a small percentage of the wells reported.

Bottom Hole Pressure

Bottom hole pressure was certainly a variable to be studied. For statistical purposes, the wells were divided into four categories:

1) those wells with less than 3000 psi bottom hole pressure,
2) those with a pressure of between 3000 and 4000 psi,
3) those with a pressure between 4000 and 5000 psi, and finally
4) those with a pressure exceeding 5000 psi.

It may be seen that a correlation between intensity of corrosion and bottom hole pressure does exist. With increasing bottom hole pressures, there is a noted increase in corrosion intensity.

Bottom Hole Temperature

Bottom hole temperature also indicated a significant pattern. Here three categories were used:

1) temperatures below 200° F.,
2) temperatures between 200° and 225° F., and
3) temperatures exceeding 225° F.

It may be seen that only 2 percent of the wells reported corrosive fell into the first or low temperature category of below 200° F, whereas 65 percent of the wells were considered corrosive if their bottom hole temperatures ranged between 200 and 225° F. Some 93 percent of the wells reported were considered corrosive if the bottom hole temperature exceeded 225° F.

Surface tubing pressure is related, of course, to bottom hole pressure, and approximately the same correlations were noted.

Gas-Oil Ratio

Gas-oil ratio was thought to be an important factor in the intensity of corrosion. The categories for gas-oil ratio were:

1) a ratio of below 4000
2) a ratio between 4000 and 10,000, and
3) a ratio greater than 10,000.

The anticipated correlation did not materialize. However, for some reason, unexplained to date, it may be seen that a larger percentage of wells were reported corrosive in the category below 4000 than were shown corrosive in the range 4000 to 10,000. Above 10,000 the percentage of corrosive wells exceeded all other categories.

Depth of Wells

The last variable considered was that of depth. Four categories were studied:

1) wells less than 8000 feet,
2) wells between 8000 and 10,000 feet,
3) wells between 10,000 and 12,000 feet, and
4) wells greater than 12,000 feet.

A very interesting correlation is evident. It may be seen that for the four categories the incidence of corrosion increases directly with depth. This is significant, since as is well known, the industry's trend is toward deeper wells. In the January, 1951, issue of *Oil and Gas Journal* it was shown that 10 percent more wells were drilled in 1950 than in 1949. Correspondingly, 15 percent more footage was drilled. This point may be further emphasized when it is noted that most of the deeper wells, that is below 12,000 feet, were in the Southern Louisiana area where this problem has been most severe. From the statistical data presented herein, it follows that with the advent of deeper drilling, the intensity of the high pressure sweet oil well corrosion problem will increase many fold.

Practically every known remedial measure has been tried to mitigate corrosion in high pressure sweet oil wells. Varying degrees of success have been reported. It was pointed out previously in the literature[2] that baked-on phenolic resins offer satisfactory and economical protection under the defined conditions. Since that early work, additional evidence has been produced which, in part, substantiates the early hypothesis, but does introduce a possible disadvantage. Figure 10 illustrates the attack on uncoated J-55 tubing after 36 months service beginning with the initial completion of the well as compared with the attack on plastic coated pipe after 19 months service in the same well. At first glance it would appear that the protective coating was performing an excellent job. However, upon close examination it may be seen that although generalized corrosion is absent there are a number of pits in isolated areas. It must be remembered that a single complete penetration in a 10,000-foot string of tubing will result in a workover. Since only 20 to 25 percent of the cost of the workover is for materials, it is readily apparent that, unless complete penetrations can be avoided, it will be difficult to justify added expenditure for corrosion resistant materials or coatings. It should be mentioned that, in all probability, numerous failures of coated pipe such as those demonstrated in Figure 10 can be attributed to poor or inadequate "culling" of the pipe before it was coated. The necessity of careful "culling" was not realized until recently. It may be that the rather isolated failures noted in Figure 10 will not occur with tubing as it is coated today. Quite a number of strings utilizing recently coated pipe were installed last year; therefore, the validity of the above supposition can be determined soon.

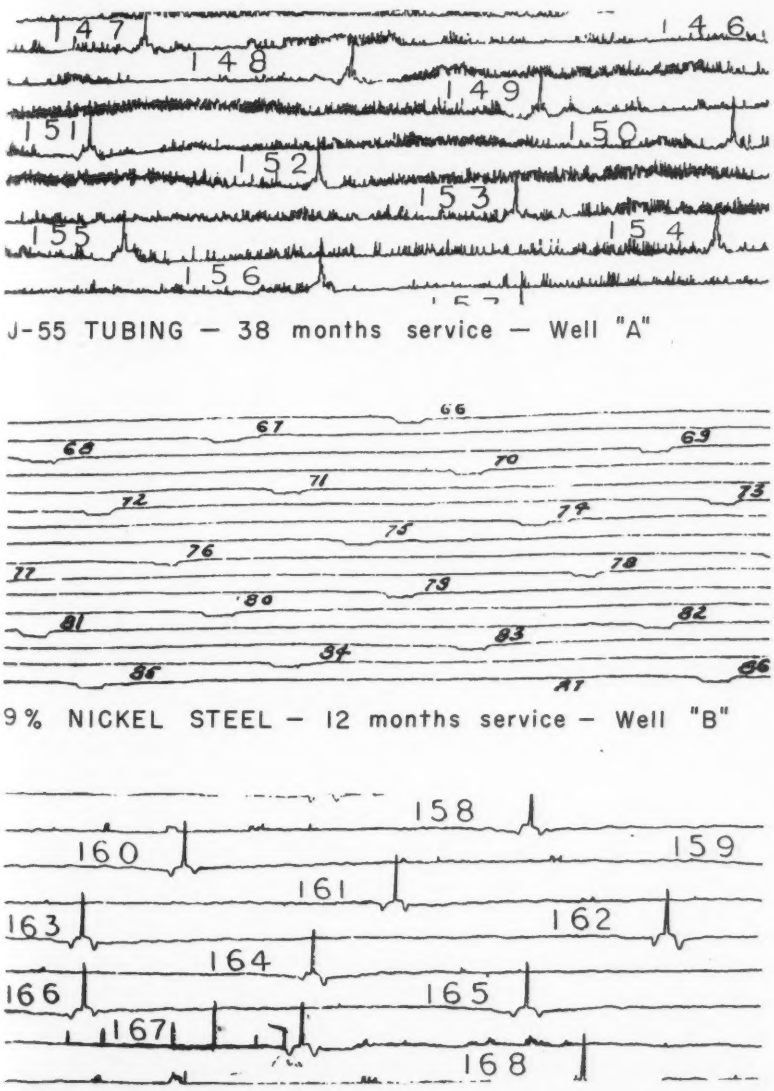

Figure 10—Survey of pitting in three kinds of tubing. J-55 tubing, 38 months' service, (Well A). 9 percent nickel tubing, 12 months' service, (Well B). Thermosetting plastic, 19 months' service, (Well A).

Phenolics Offer Promise

It is not intended that the above discussion of an outstanding disadvantage of phenolic resin coatings depreciate the importance of such coatings. As a matter of fact, until further data are advanced to the

contrary, or until more promising products are made available, it would appear that the phenolic plastic coating at present offers advantages equal to or greater than other mitigation procedures.

Tubing coated with thermosetting plastic currently costs about twice that of uncoated J-55. Thus, if its use can add three years to the service life of tubing, economic advantage may be realized. Industry-wide recognition of its value is shown by the fact that approximately 310,000 feet have been installed to date in high pressure sweet oil wells.

Nickel Alloyed Steels in Use

The apparent success of nickel alloyed steels, particularly 9 percent nickel, in the condensate well corrosion problem prompted its initial use in sweet oil well corrosion. To date approximately 70,000 feet, or seven strings, have been installed in one field in Southern Louisiana. Although it is too soon to make conclusions regarding its ultimate effectiveness, it may be seen from Figure 10 that, after one year's service, no measurable pitting has been experienced.

The cost of 9 percent nickel steel is approximately four times that of regular J-55. Thus, it may be seen that its general use must be limited to areas where workover costs are exceptionally high.

Metal Plating Is Tried

Metal plating in two forms has been field tested. Approximately 20,000 feet, or two strings, of galvanized tubing were placed in service several years ago. Experience indicated that galvanizing offered no significant advantage. The failure of this material confirmed the NACE alloy evaluation test conducted by the Condensate Well Corrosion Committee.

Nickel plated tubing became available last year for the first time. Theoretically, it offered much promise; in addition, the NACE alloy evaluation tests indicated that it was very corrosion resistant, at least in the condensate well environment. Several companies were planning an extensive evaluation of this material during the latter months of 1950 but a cut in the allotment of nickel to the petroleum industry made the tests impossible.

The cost of nickel plated tubing was approximately 2½ times that of J-55. Should this material be made available to the petroleum industry soon, its use as a corrosion resistant tubing material might gain in popularity.

Inhibitors Are Not Successful

The use of inhibitors has not proved successful in combating high pressure sweet oil well corrosion. The reason is not ineffectiveness of inhibitors, but the difficulty of utilizing known techniques of injection. Physical conditions prevalent in the completion of such wells preclude the introduction of chemicals into the annulus; therefore, the only practical means of introducing inhibitors is through the tubing. Since this phase contains a full head of production fluid at all times, the possibility of successfully injecting liquid inhibitors into the tubing is practically nil. Organic materials in solid form have been tried in eight wells in Southern Louisiana. To date they have proved unsuccessful in all cases.

In conclusion, a brief review of the factors considered in the study of this problem might be listed as follows:

1. Potential expenditures resulting from corrosion in the defined category are tremendous. Realistic estimates are difficult to make due to the extreme "risk-hazards" involved in high surface pressure operations.
2. General pitting type corrosion occurs frequently in wells producing pipe line oil. The attack continues after wells begin producing water.
3. Pitting frequently varies with deviations in wall thickness of the tubing. Maximum concentration is experienced at points of minimum wall thickness.
4. Unique and unexplained scale conditions have been observed.
5. Average tubing life in the wells considered has been from three to four years.
6. Popular criteria of corrosion as utilized in other problems are difficult of interpretation.
7. The intensity of corrosion apparently varies with carbon dioxide content.
8. Organic acids in large concentrations are prevalent.
9. Most known remedial measures have been tried. Inhibitors have proved unsuccessful. Galvanizing has been of no value. Thermosetting plastic tubing, with exceptions, has been very promising. Nine percent nickel alloyed steel seems to afford a solution in areas where workover costs are high. Nickel plated steel, although as yet untried in the field, seems to theoretically offer considerable advantage.

An economic analysis of the problem indicates that ample justification exists for continued effort toward a satisfactory solution. A specific example illustrating this point might afford an appropriate conclusion to this report. It may be assumed from the data herein presented that tubing must be replaced after a maximum of four years' service. Based upon figures reported by several companies, the cost of a single workover may be conservatively estimated at $10,000. Actual costs have in many instances exceeded this amount by 100 percent. Statistical data disclosed approximately 150 corrosive wells concentrated in a limited geographic area. Thus it follows that, neglecting completely potential expenditures resulting from the aforementioned "risk-hazards," $1,500,000 must be spent because of corrosion within the next four years, or $375,000 per year must be added to the lifting cost of 150 wells.

Acknowledgment

The author acknowledges the cooperation of NACE TP-1 committee members, without whose help the preparation of this paper would have been impossible.

In addition, much credit is due engineers within Atlantic Refining Company's organization for the compilation and aid in interpretation of data.

The kind permission of The Atlantic Refining Company to publish this paper is appreciated.

References

1. H. E. Waldrip. "Present Day Aspects of Condensate Well Corrosion." *Corrosion*, **4**, No. 12, 611 Dec. (1948).
2. R. C. Buchan. "Corrosion in Condensate and in High Pressure Sweet Oil Wells." *Corrosion*, **6**, No. 6, 178 June (1950).
3. T. S. Bacon and E. A. Brown. "Corrosion in Distillate Wells." NGAA, April, 1943.
4. W. F. Rogers. "Present Day Aspects of High Pressure Well Equipment Corrosion." *World Oil*, **128**, No. 6, 154 Oct. (1948).
5. P. L. Menaul. "Causative Agents of Corrosion in Distillate Fields." *Oil, and Gas J.* **43**, No. 27, 80 Nov. (1944).

Corrosion Studies of Iron In the Presence of Sulfur*

By RAYMOND B. SEYMOUR, WALTER R. PASCOE and R. D. STOUT

Introduction

MOLTEN SULFUR and admixtures have been used for centuries for jointing various materials. That properly compounded compositions are satisfactory is attested by sulfur-jointed headstones in New England graveyards which have withstood the test of time for over two centuries. Quite recently, pipe estimated to have been joined with sulfur cement at least a century ago was unearthed at Wilmington, N. C., and found to be in excellent condition.

The purpose of this study was to determine the effects of various additives both in the sulfur cement and in the surrounding aqueous solution when an interface of iron and sulfur was present in contact with water. No corrosion was observed in this investigation when the iron was protected by even thin layers of sulfur cement. These studies have given considerable information on corrosion at this interface but should not be misinterpreted in so far as the performance of sulfur joints in cast iron pipe are concerned. Historical evidence and the results of this investigation indicate that properly prepared sulfur cement joints are satisfactory in bell and spigot cast iron water mains.

A sulfur cement plasticized with Thiokol has been used as a jointing material for brick in acid pickling tanks and installations are known to be in service in which the sulfur cement has been in continuous contact with hot sulfuric acid for at least fifteen years. In spite of the previously cited utility of sulfur admixtures for joining bell and spigot joints in cast iron water mains, little fundamental data have been published and, therefore, this investigation was undertaken to supply information needed by corrosion engineers.

Discussion

The composition chosen for this study was one described by Duecker, viz., 58.8% sulfur, 38.0% graded silica, 2.0% carbon black and 1.2% Thiokol. This composition, which has a tensile strength of greater than 750 psi, a compressive strength of greater than 6000 psi, a modulus of rupture greater than 2200 psi, and a coefficient of expansion of 9×10^{-6} in. per degree F has also been modified in this investigation by the addition of minor amounts of other materials and by the complete replacement of silica by carbon.

The method of study consisted in partly or completely embedding an iron rod in a molten composition

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RAYMOND B. SEYMOUR—Executive Vice-President and Technical Director of Atlas Mineral Products Co., Mertztown, Pa., holds degrees from the University of New Hampshire and a doctorate of philosophy at University of Iowa, 1937. He has been Research Chemist for Goodyear Tire & Rubber Co., Director, Industrial Research Institute, University of Chattanooga, Tenn., and has held various positions with Atlas Mineral Products Co. He is author and co-author of several papers on paints, finishes and industrial research.

WALTER R. PASCOE—A graduate of Pennsylvania State University, he has specialized in corrosion studies of sulfur cements since joining Atlas Mineral Products Company in 1949.

ROBERT D. STOUT—Professor in the Department of Metallurgy, Lehigh University, Bethlehem, Pa., he holds a B.S. from Pennsylvania State College, and a master's and Ph.D. degrees from Lehigh University. He was associated with Carpenter Steel Co. before going to Lehigh as an instructor in 1939, and was awarded the Lincoln Gold Medal by American Welding Society in 1943. He also did work for the National Defense Research Committee, and the Office of Scientific Research and Development. He has done experimental work on the torsion impact testing of tool steel and on weldability of steel.

Abstract

The authors give details of a study to determine effects of additives in sulfur cement and in surrounding aqueous solution when an interface of iron and sulfur was present in contact with water. No corrosion was observed when the iron was protected by even thin layers of sulfur cement. While information on corrosion at this interface was obtained it should not be misinterpreted insofar as performance of sulfur joints in cast iron pipe is concerned. Historical evidence and results of this study indicate properly prepared sulfur cement joints are satisfactory in bell and spigot cast iron water mains. The study consisted in partly or completely embedding an iron rod in a molten composition based on sulfur and immersing the resulting mass in water under various conditions.

The addition of sodium chloride to the sulfur cement accelerated corrosion of the iron at the sulfur iron interface. Completely embedded iron rods in a silica-filled sulfur cement were unaffected after two years' immersion in tap water, water at various conditions of pH and in the presence of aqueous sodium chloride.

based on sulfur and immersing the resulting mass in water under various conditions. Because of the ready availability of molds, the small amount of material used and the possibility of determining the effect of immersion on tensile strength, figure eight briquettes were used throughout this investigation.

It should be emphasized that neither a completely embedded nor a partly exposed iron rod in a figure eight briquette represents the actual conditions existing in a bell and spigot cast iron pipe joint, but undoubtedly practical conditions vary somewhere between these two extremes. Because of the low water absorption of sulfur, even highly corrosive aqueous solutions would not be expected to have any deleterious effect on a completely embedded iron rod. Actually, in this investigation, completely embedded iron rods were unaffected after immersion for two years in water at pH's varying from 4 to 9 in the presence and absence of saturated sodium chloride solution at room temperature. This phenomenon was true even when the thickness of the protecting sulfur cement over the iron was a little as ⅛-inch in thickness. The figure eight briquettes suffered less than 20% decrease in tensile strength as a result of this long time immersion. However, when the iron rod was only partly covered by the sulfur, corrosion took place at the interface.

An investigation of bell and spigot cast iron pipe joints of sulfur admixtures has shown that a thin dark ring, presumably iron sulfide, formed at the iron-sulfur joint interface. Joints were observed after twenty years of service and showed no progressive migration of this dark ring. However, the results of these experiences indicate that this phenomenon may be affected by additives and by the pH of the surrounding medium.

The properties of mixtures of sulfur and aggregates are different from those of pure sulfur and depend to a large extent on the materials present. All known proprietary preparations consist essentially of sulfur and silica filler. Variations in these two components will produce cements having tensile strengths from 250 to 700 psi, moduli of rupture from 800 to 2100 psi and coefficients of expansion from 30×10^{-6} to 50×10^{-6} in per degree F. According to Duecker,[1] the addition of 2 percent carbon black increases the strength, minimizes settling and improves workability of sulfur cements. Most commercial compounds contain varying amounts of carbon black. Compositions containing all carbon and sulfur have given excellent service in stainless steel pickling tanks which utilize hydrofluoric acid but such materials would not be entirely satisfactory for water-main joints due to their high conductivity and possible galvanic effects.

Cements having 1 percent Thiokol are said to be superior to lead in their resistance to vibration and changes in temperature.[2] Continued investigations over a period of years have shown that cements having high coefficient of expansion will develop cracks on cooling.

The addition of iron filings[3] has been advocated and while a reaction may take place during heating, any action between the sulfur and iron at normal temperatures in the absence of water would be negligible.[4] Mock[5] has produced an insulator by leaching soluble salts from a mixture of sulfur and sodium chloride. Duecker[6] and co-workers have shown that sulfur cements containing 1 percent or more copper sulfate spalled and crazed rapidly when buried in the ground.

Since sulfur does not react with iron in the absence of moisture at elevated temperatures in air,[4,7] it has been proposed as a protective spray coat for iron[8,9] and as an inhibitor to prevent the corrosive action of molten organic liquids in contact with this metal.[10] Spitz[11] has shown cast iron to have satisfactory corrosion resistance to sulfur and no effect has been noted on pipe used to transport liquid sulfur during a twelve year period.[7] However, the addition of 15 percent water caused corrosion to take place which could be minimized by the addition of sodium bicarbonate. West has shown no corrosion to take place with iron in the presence of molten sulfur in the absence of water. However, pitting at the rate of 1, 15 and 400 mils per year took place in the presence of 0.5, 6.4 and 20 percent water respectively. Shock and Hackerman[12] have studied the corrosion of a sulfur, iron, water, sodium chloride system.

Considerable information on the effect of sulfur on iron in the presence of water can be obtained by a study of the previously described figure-eight briquettes immersed in water in the presence of exposed or protected iron. It is well known that a piece of cast iron corrodes when immersed in tap water and that the rate of this corrosion is a function of the pH of the surrounding water. The results of this investigation have shown that corrosion of exposed iron in sulfur briquettes is dependent upon the pH and presence of soluble salts in the solution, as well as the presence of conductive materials such as soluble salts, carbon or powdered metal in the sulfur cement. In this study, corrosion was measured qualitatively and the minimum time required for one of three briquettes to crack at ordinary room temperatures was recorded. The difference between cast iron rods and nails was observed to be within the limits of duplicability of this experiment.

Experimental

As is evident from the data in Table 1, briquettes of a soluble salt-free sulfur cement with exposed embedded iron rods cracked most rapidly at a pH of 9 but did not crack after 18 months at a pH of 4 to 8. These specimens after over 18 months of immersion at various conditions of pH are shown in Figure 1.

TABLE I

The effect of pH and Composition on the Cracking Time of Sulfur Cements Containing Partly Embedded Iron Rods

pH of Sol.	TIME (Months) FOR BRIQUETTES TO CRACK		
	Salt-Free Sulfur Cement Immersed in Water	Salt-Free Sulfur Cement Immersed in Saturated Salt Solution	Sulfur Cement Containing 2 Percent NaCl Immersed in Water
4	18+	18+	2
5	18+	18+	2
6	18+	18+	2
7	18+	18+	2
8	18+	18+	2
9	4	18+	2

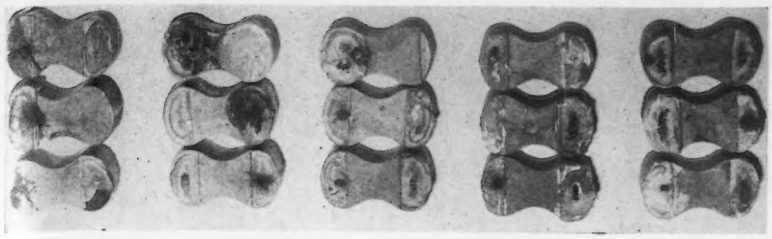


Figure 1.—Specimens described in Column 1 of Table I.

Figure 2—Showing salt containing specimens after two months' immersion at various conditions of pH.

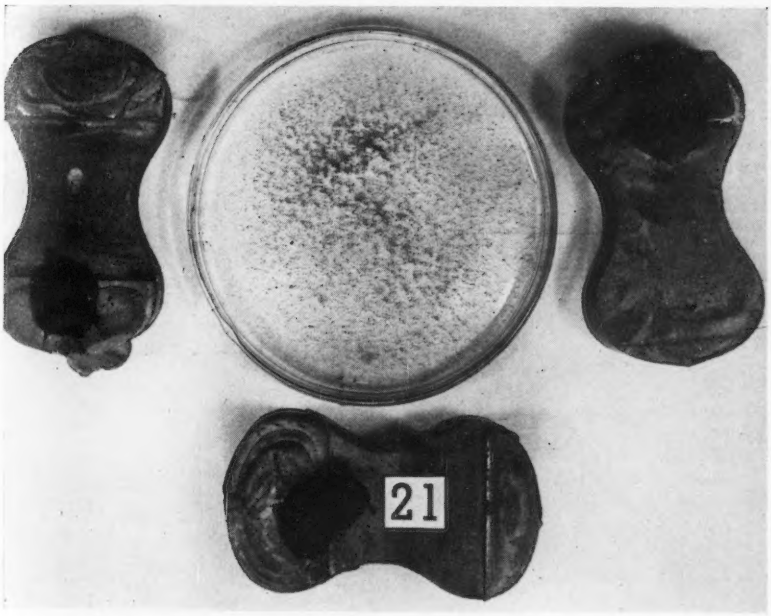


Figure 3—Showing residue in petri dish after 40 days' immersion of uncoated iron nails in sulfur cement.

The addition of sufficient sodium chloride to saturate this solution had essentially no effect on this cracking rate but it did accelerate the corrosion of the iron at the sulfur-iron interface. In addition, when sodium chloride was present in the solution, a pitting of the sulfur cement took place around the iron rod after twelve months' immersion. Both in the presence and absence of sodium chloride, the rod became completely corroded through but the time required for this to take place was decreased considerably by the presence of sodium chloride. The various pH's were obtained by the use of McIlvaine's Buffer System.

When 2 percent sodium chloride was added to the sulfur cement composition itself, the rate of cracking of the iron rod-containing briquettes was greatly accelerated regardless of conditions of pH. The effect of two months' immersion of the salt-containing briquette is shown in Figure 2.

When the graded silica aggregate was replaced by carbon aggregate, interfacial corrosion in non-saline solutions was accelerated but there was no evidence of cracking of the iron rod-containing briquettes. The rate of corrosion of the iron rods partly immersed in carbon-sulfur compositions was greatly accelerated when sodium chloride was added to the surrounding water. Repetition of these tests using sulfur in the absence of aggregates showed that such specimens cracked much sooner than silica-filled aggregates possibly as a consequence of the reduced strength of the composition.

Figure 3 shows the amount of residue resulting from the immersion of three salt-free briquettes after exposure for 40 days at a pH of 8. Figure 4 shows a similar study with briquettes containing 2 percent sodium chloride. It is of interest to note that the effects shown in Figure 4 could be completely eliminated by coating the nails with a commercial vinyl base coating. As will be seen in Figure 5, no residue whatsoever was collected after 40 days immersion of such specimens.

As is evident by data in Table II, the addition of powdered metals such as aluminum, lead, iron, zinc or even iron and copper chromate, decrease the cracking time considerably.

As might be expected, completely embedded iron rods in a silica-filled sulfur cement were unaffected after two years' immersion in tap water, water at various conditions of pH and in the presence of aqueous sodium chloride. When the iron rod was

TABLE II

Cracking Time of Sulfur Cements Containing 5 percent Metal or Metal Salt Additives when Immersed in Water at a pH of 8.5

Control	Minimum Cracking Time (Months)
Control	18+
Aluminum	8
Zinc	6
Lead	2
Iron	2
Copper Chromate	3
Iron Chromate	1

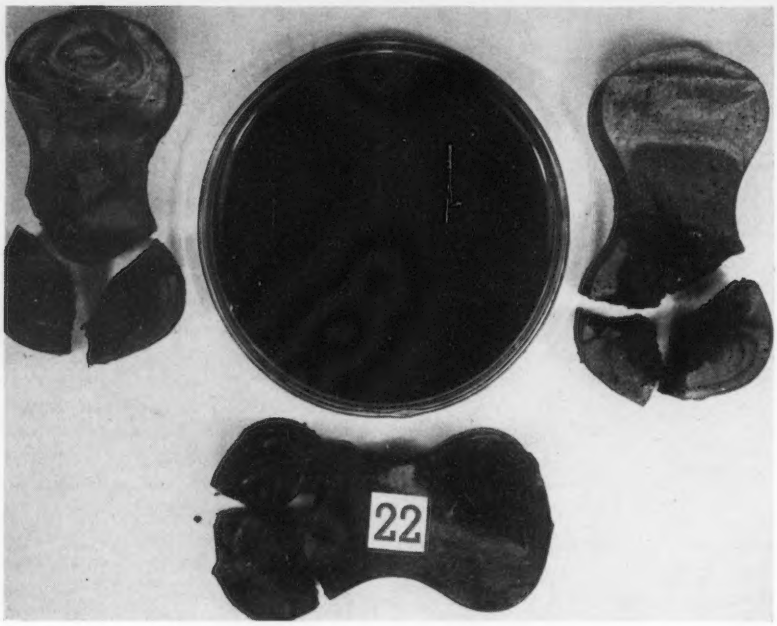
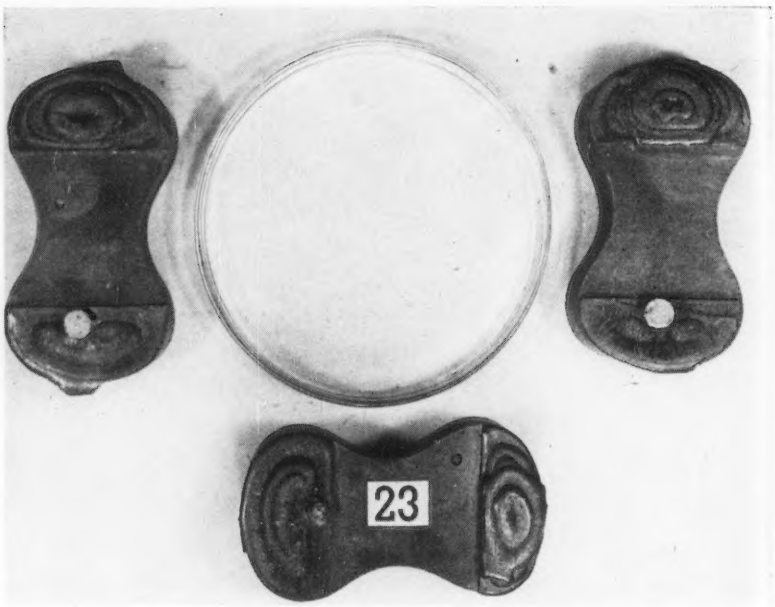


Figure 4—Showing residue in petri dish after 40 days' immersion of iron nails in briquettes containing 2 percent salt.

Figure 5—Petri dish shows essentially no residue resulting from immersion of briquettes containing coated iron nails after 40 days' immersion.

completely immersed in the sulfur cement, no difference was noted between silica and carbon-filled cements and the tensile strength of all cements was essentially unaltered as a result of long time immersion.

When the iron rod was only partly embedded in the cement and the specimen was immersed in water, corrosion took place at the interface and the briquette cracked and finally broke. The presence of electrolytes in the sulfur cement or in the surrounding water accelerated corrosion and cracking.



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References

1. W. W. Duecker. *Chem. and Met. Engr.*, **41,** No. 1, 583-6 (1934).
2. C. R. Payne. *Eng. and Contract Record,* **50,** No. 93, 14-17 (1937).
3. W. W. Barnes. U. S. 339,519, Apr. 6, 1886.
4. I. I. Kornilov. *Bull. Acad. Sci. (USSR) Iosse Sci. Chem.*, 345-6 (1947).
5. H. Mock. U. S. 1,297,583, Mar. 18, 1918.
6. W. W. Duecker, J. W. Estep, M. G. Mayberry and J. W. Schwab. *J. AWWA,* **40,** No. 7, 715 (1948).
7. J. R. West. *Chem. Eng.*, **53,** No. 10, 226 (1946).
8. Campagnie Des Metaux D'overpelt Lommel et de Corphalie, Belg. 367,309. Feb. 28, 1932.
9. N. W. Greenwood. *Paint. Manuf.*, **18,** 50-1 (1948).
10. L. Egerton. U. S. 2,287,421, June 23, 1942.
11. A. W. Spitz. *Chem. Eng.*, **54,** No. 2, 135 (1947).
12. D. A. Shock and Norman Hackerman. *Corrosion,* **6,** 195 (1950).

Control of Corrosion Damage To Rolling Stock Through Proper Design And Maintenance*

By F. K. MITCHELL*

Abstract

The portion of the money spent by the New York Central System to repair ravages of corrosion out of the whole maintenance expenditure is astounding. Overall corrosion repair cost to freight cars was approximately 33.5 percent and to passenger cars 28.9 percent. Figures compiled by the American Association of Railroads show $428,306,950 spent for freight car repairs and $163,773,669 spent for passenger car repairs in 1949 by U. S. railroads. Applying the percentages attributed to corrosion to the total cost of repairs gives cost of corrosion alone as $143,482,828 for freight cars and $47,330,590 for passenger cars. Principal causes of corrosion discovered by New York Central were trapped moisture, due to faulty sealing or design, stress damage due to faulty design, use of wood-metal joints, electrolytic corrosion as a result of dissimilar metals or materials incompatible with metals, poor maintenance and repair practices and improper use of cleaning compounds. Correction of these causes through the proper design and selection of structural and maintenance materials, improved maintenance practices and methods is being consistently pursued.

THE PURPOSE of this paper is to create a greater consciousness of the part corrosion damage plays in the cost of repairs and shortened service life of passenger and freight equipment cars. The railroads have been confronted with this problem for many years, but corrosion has been approached in a more or less lackadaisical manner and probably without full recognition of its extreme importance.

In order to obtain information about the need for a better approach to this problem, the author's company conducted a research program into the question of what portion of maintenance cost on passenger and freight cars is attributable to corrosion damage and the cost of repairs resulting from corrosion damages. The enormity of the figures obtained from this investigation are astounding. From the results of this study it is hoped that others will be inspired to make similar investigations and combine their studies with real concerted effort to come up with improved designs and maintenance methods which will eventually contribute materially to reducing overall maintenance costs and increasing the life of various types of rolling stock.

Ratio of Corrosion Cost to Total Repair Cost

This investigation, although by no means complete, indicates that the ratio of corrosion damage repair to total repair costs on selected types of rolling stock is approximately as follows:

Hopper cars	64%
Gondola cars	58%
Box cars	19%
Flat cars	8%
Coaches	25%
Baggage cars	40%
Passenger-and-Baggage cars	35%
Mail-and-Baggage cars	33%

Based on these figures the overall corrosion repair cost on freight cars was approximately 33.5 percent and on passenger equipment cars 28.9 percent. The American Association of Railroads' records for 1949 indicate that the railroad companies of the United States spent $428,306,950 for freight car repairs and $163,773,669 for passenger car repairs. Application of these percentages to national costs indicates that corrosion damage repairs were $143,482,828 for freight cars and $47,330,590 for passenger equipment cars. Certainly these figures indicate that there is no wider field for reduction in overall maintenance costs than in corrosion. Figure 1 emphasizes this in an even more striking manner. The portion of the maintenance dollar which is attributable to corrosion damage repairs as compared with the total for both types of rolling stock is shown diagrammatically.

No further incentive should be required to attack the problem wisely and sincerely and leave no stone unturned until every possible change in maintenance and design practice is made to help the situation. In order to approach this problem with some semblance of logic, there should be a clear understanding of what causes corrosion damage. Corrosion types are varied and in each case the approach to correction of the damage may have to be different. Perhaps the outstanding causes for the various types of corrosion on rolling stock are rust, acid (chemical) and electrolytic reactions.

Confined Moisture Accelerates Rust Damage

Corrosion damage resulting from what is ordinarily known as rust is probably the one with which most people are familiar. Rust being the result of oxidation of iron and steel presupposes the presence

The freight car maintenance dollar

The passenger car maintenance dollar

Figure 1

★ An address before the Car Department Association of St. Louis. Presented for publication May 21, 1951. Previously published in the proceedings of the Car Department Association. Extracts have appeared in the Mechanical Engineer and other railroad periodicals.

* Manager, Equipment, New York Central System.

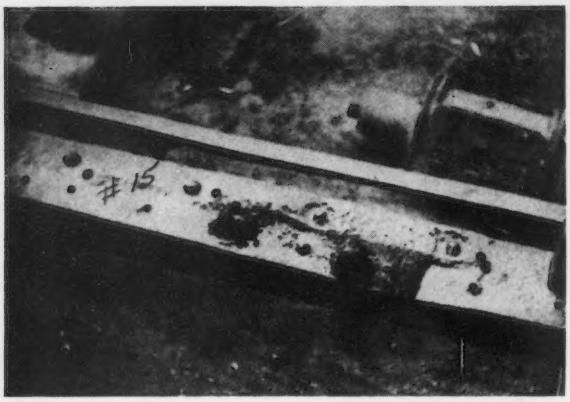

Figure 2—Corroded section of a steel box car floor bolting flange in doorway of car.

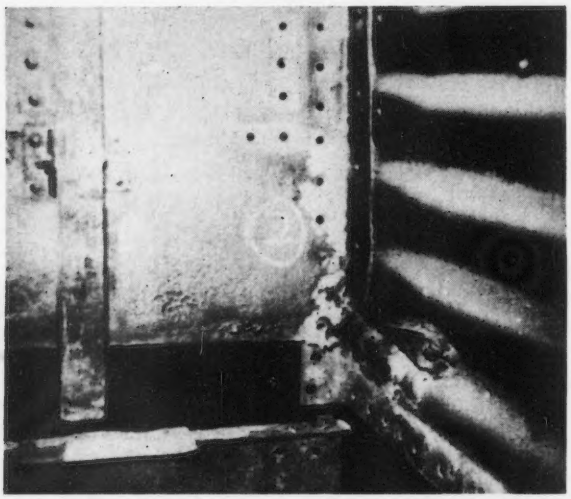

Figure 3—Corroded section of steel box car side sheet at corner underneath corrugated steel end.

of moisture. Its action is the greatest and the damage most accelerated when there is presence of moisture in the confined areas and the metal is unprotected by a satisfactory coating. A typical example of rust damage is shown in Figures 2 and 3.

Rust is seldom, however, a reaction which is entirely due to the presence of moisture and unprotected metal surfaces. The proof of this can readily be found in the fact that in certain locations rust is far more active than in others. For instance, on a gondola car the rust deterioration of the side sheets is far more rapid in the lower half and even in the lower ten or twelve inches. This is true whether the inside surface of the side sheet has been treated to prevent corrosion or not. The same is true on a box car. In due time rust results in the material wasting entirely away at and slightly above the floor line. Now these corrosive or rusting actions would have proceeded uniformly over the surface of the side sheets had not other factors accelerated the action in the location being considered. One of the principal factors which accelerates corrosion at this particular point in the type of car referred to is undoubtedly acid. The presence of acid along with moisture reacts not only with

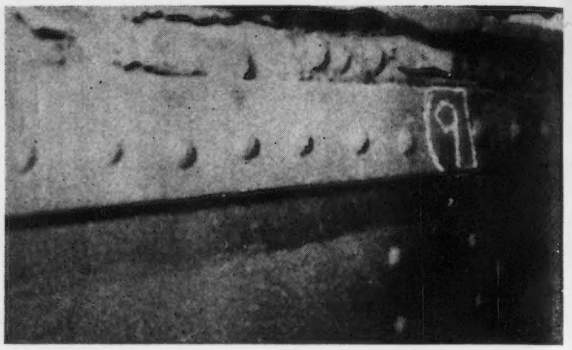

Figure 4—Section of angle connecting "Z" bar side plate and roof sheet.

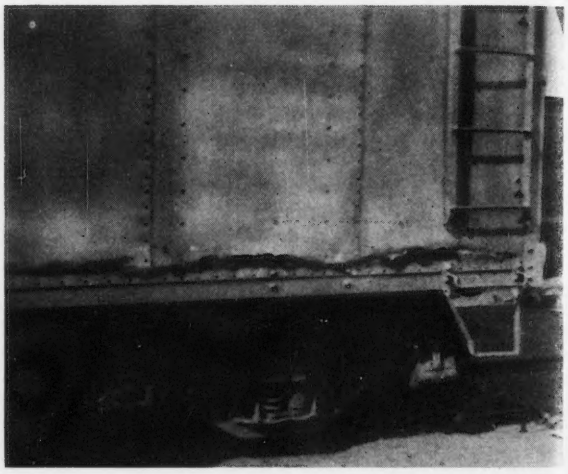

Figure 5—Section of steel box car side sheet at floor line.

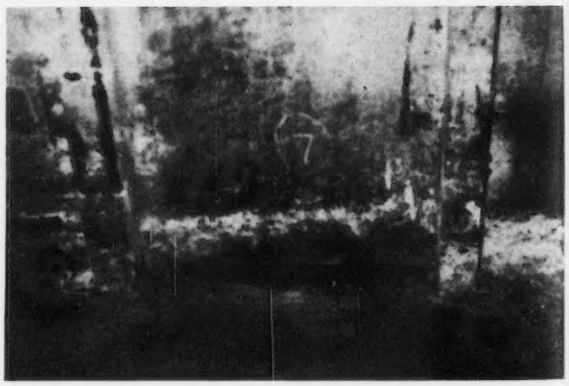

Figure 6—Inside section of steel box car side sheet at floor line.

the steel side sheet, but with the lading in this location and the resultant deterioration is accelerated by both actions at the same point.

Stress Concentration Important

Another important corrosion accelerator that speeds up deterioration in the locations just referred to, which has in the past received very little attention is the concentration of stresses. The relatively weak superstructure of a box car and inadequate bracing of side sheets in a gondola car unfortunately

concentrate stresses in the area where corrosion is most active. Concentrated stresses in this area are responsible for the gradual deterioration of the metal even though corrosion is not present. In these overstressed areas, microscopic fractures or molecular slip bands result into which the elements of corrosion may enter and begin to work. The results are tragic. Figure 4 shows damage from rust and concentrated stresses at the side sheet and roof sheet connection. Figures 5 and 6 illustrate corrosion damage at the floor line from rust, acid reaction and concentrated stresses.

What has been said with respect to box and gondola cars is equally true on hopper cars. Experience has shown that the deterioration on this type car is greatest on the hoppers and on the side sheets just above the connection to the slope sheets. The damage to the hopper, depending upon its construction, is normally the result of rust and acid corrosion. With the built-up hopper which has a reinforcing strip across the mouth the corrosion damage is often accelerated along the upper edge of the strip. At this location stress concentration has accelerated the damage. (Figure 7) Figure 8 illustrates the combination of rust, acid and stress concentration corrosion damage to the side sheets of the steel hopper car.

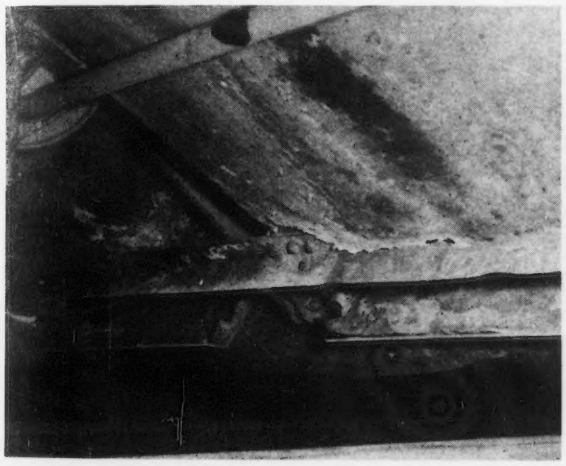

Figure 7—Rust, acid and fatigue stress at the hopper reinforcing strip on a built-up hopper.

Figure 8—The effect of rust, acid and fatigue stress at the slope sheet and side sheet connectinon of a steel hopper car.

Passenger Car Damage Concealed

On the passenger car, the greatest corrosion damage is usually concealed. It is, however, invariably found to be the greatest where it is possible for moisture to accumulate between two sheets or shapes. Figure 9 gives a good illustration of the deterioration of the passenger car at the step location which is subjected to moisture from exterior sources and quite often to acid from refuse discharged from the car. Figure 10 shows the results of corrosion damage at

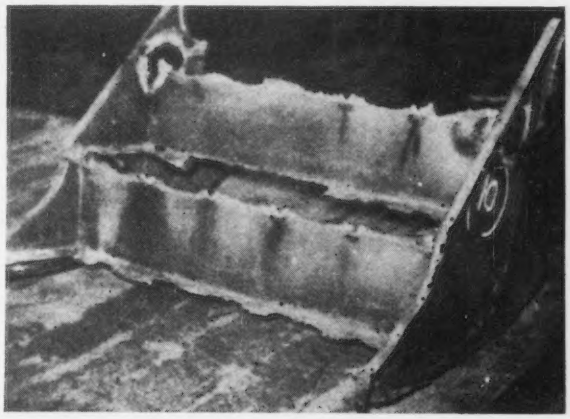

Figure 9—Step riser and step side flanges of folding step of a lightweight passenger car.

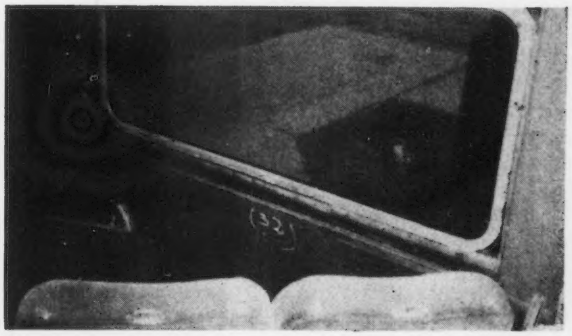

Figure 10—Corrosion damage at window of lightweight coach as observed before sash was removed.

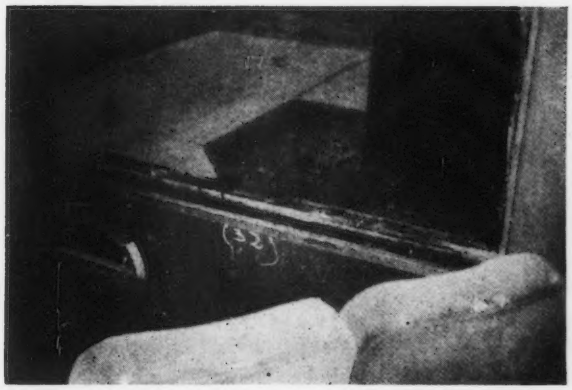

Figure 11—Corrosion damage at window after sash was removed. The sub sill was rusted through in places; adjacent side sheet badly corroded and bulged by rust; wainscoting streaked and warped.

Figure 12—Deterioration of a passenger car battery box door from acid corrosion.

the sub-window sill of a lightweight coach as evidenced prior to the removal of the sash; further damage evident after the sash was removed appears in Figure 11. In this case both the sub sill and the adjacent side sheet were badly corroded, the side sheet was bulged at the sub sill and the wainscoting was streaked and warped below the window opening.

There are some types of corrosion damage on passenger cars which are strictly due to acid reaction. The most outstanding of these is the damage to battery boxes (Figure 12). The acid attacking the metal in this instance is more concentrated than that referred to as accelerating corrosion damage in the other items discussed, the latter being more diluted and requiring a much greater time to show its effect.

In passenger car construction, experience has shown it is possible to promote very rapid and expensive corrosion damage through the wrong combination of materials. One of the most striking examples of this type of corrosion has occurred where aluminum bulkheads have been entirely corroded away at the floor line by reaction of a floor cement containing ingredients which actively attack the aluminum. In some instances this reaction has proceeded to the point where the aluminum salt produced by the reaction raised the floor to a point where doors in the bulkheads could no longer be operated.

To this point typical kinds of corrosion have been cited; instances where it is a combination of rust, chemical and stress concentration; where it is from chemical reaction alone, and where it is a chemical reaction set up by abutting materials.

There are two further types of corrosion damage which cannot be overlooked. The first of these is what is known as rot of wood parts. Experience has shown that this is accelerated by placing the wood against steel and by failure to properly seal water out of such a union. The second, which is not generally understood and which is not too common, is the electrolytic action which may be incurred by the improper selection of materials which go into the construction of a car. No study of the entire problem can overlook any of the previously referred to types of corrosion nor the fact that there may be other types which are not so familiar.

Having outlined briefly the cost of corrosion damage, the types of corrosion which are causing very substantial outlays of maintenance money and shortening the life of rolling stock, the possibilities of reducing corrosion through proper equipment design and maintenance methods will be considered.

Elimination of Wood Important

The simplest part of the problem to understand is, of course, those features which are referred to normally as rot and rust. The easiest way to dispose of the rot question is to entirely eliminate wood from rolling stock construction. This has been accomplished to a large extent already. The future will probably see wood entirely eliminated from all types of rolling stock. Where it is still necessary to use wood, however, careful consideration should be given to the advisability of proper impregnation with materials to prevent absorption of moisture and prevention of rot. Furthermore, where it is necessary to use combinations of steel and wood construction, all joints should be carefully insulated against moisture by approved cements or other chemicals designed for the same purposes. Selection of wood, where necessary to use it, should not forego the adoption of a type of wood that is less susceptible to rot, even though more expensive.

High Quality Coatings Are Economical

The elimination of corrosion damage by what is known as simple rust can be and must be approached from two principal points of view. The metals selected should be those which are least susceptible to rust. Concerning this phase, however, the first cost cannot always be overlooked. Therefore, when it is necessary to use metals which are susceptible to rust under normal conditions every effort should be made to protect them. Sealing compounds should be used between the sheets at the joints as should be paint which will seal exposed portions of the metal in a satisfactory way between normal shopping periods for the equipment. No niggardliness should enter into the selection of the material and paint to be used. The cheapest protection in the long run is the primer and paint which will retain its protective value over the longest period of time. Because of the highly corrosive nature of some of the lading handled in various types of freight cars, even the best known primers and paints cannot be expected to properly protect the exposed surfaces of the metal parts of a car throughout its normal shopping period. Therefore, it is essential on any railroad that a program for repainting at satisfactory intervals between general repairs be set up if the life of the car is to be prolonged. An example of what happens when this is not done is shown in Figure 13, a covered hopper where the lading has destroyed the protective coating.

The next step in the prevention of normal rust

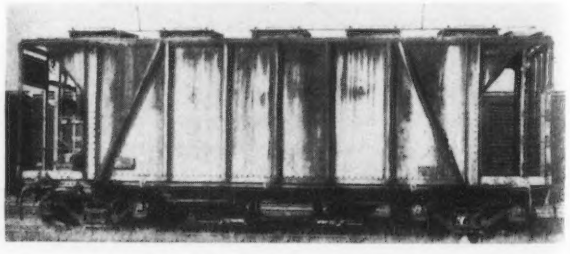

Figure 13—Lading corrosion damage to paint on exterior of covered hopper car after two years service.

damage and indeed in the elimination of acid corrosion damage resulting from moisture and lading reaction is sealing by welding or other methods all joints in the areas where corrosion is known to be most active. This is imperative for lap joints where corrosion can take place between the sheets. If lap joints must be used, the elimination of corrosion demands that the surfaces between these metal parts be properly protected by acceptable cement, and then the edges sealed by welding. What happens when this is not done is well illustrated by reference to Figure 3 which shows the side sheets of a box car deteriorated to a feather edge under the lap of a steel end.

Joints Should Be Sealed Against Lading

In the construction of a box car the question of sealing the side sheets at the floor line against the possibility that grain or other lading might accelerate the damage is important (Figures 4 and 5). Where beveled grain strips of wood are used as is common on many roads it is impossible to keep the grain strips sufficiently tight against the side sheets and the floor to prevent the lading from sifting into the crevices. Even if wood of reasonably good quality is used, normal shrinkage and distortion will create openings that are an invitation to the gremlins of corrosion to attack at that point. If no grain strip is used, there is still the possibility and likelihood that an opening will exist between the floor board and side sheet into which lading will accumulate and start corrosive action. Some experiments have been conducted using a plastic strip troweled into position and contoured so as to not only seal the joint where the damage normally occurs, but to direct the lading out on the floor where it can be disposed of. The railroads have only just begun to touch the outer fringes of the possibilities in the use of plastics in the construction of rolling stock. The use of plastics in the elimination of all square corners at the floor of passenger cars will not only minimize the concentration of corrosion damage, but will make for much more sanitary conditions.

Design to Eliminate Concentration Stresses

The designing of rolling stock to eliminate concentration of stresses at points where corrosion damage is known to be the greatest is a study which should be progressed actively. In some instances this may mean the use of heavier sheets. In others, it may mean a strengthening of the supporting elements of the car or car parts, even though this might have a tendency to add somewhat to the weight of the car. Again in others, it may mean a big change in ideas as to the type material to be used at these locations. Take for instance the hopper car. It is a definite fact that the one-piece hopper is less susceptible to corrosion than the built-up hopper. Equally a definite fact is that the cast steel hopper is less susceptible to corrosion than either of the other two types.

However, the mere fact that a type of metal is known to be less susceptible to corrosion damage and may have some better physical properties must not entirely govern the designer's decision. Although making it possible to substitute thinner sheets or shapes, it must not be overlooked that the use of these materials in thinner sections may not be the answer because the lighter construction may lead to stress concentrations through lack of rigidity that will produce damage equal to that which would be otherwise experienced. Furthermore, the designer should keep in mind three facts:

1) The composition of the metals used usually influences corrosion much less than external conditions.
2) The difference between the corrosion resistance of various metals usually depends on the ability of each to form and maintain surface films of a protective nature, in other words, relative passivity. It should be remembered that passivity in metals is usually produced by the action of strong oxidizing solutions such as concentrated nitric acid or chromates on one hand or by making the metals anodic in an electrolyte.
3) So-called corrosion resistant or passive metals quite frequently will revert to their normal state if removed from the passifying media, especially if service requirements subject them to abrasion, heat or contact with chlorides.

Sealant for Side Sheets Needed

In the design of passenger cars, it is unfortunate that in recent years the appearances of certain external construction have been the deciding factor rather than the serviceability of the arrangement. One of the outstanding examples is the trend toward the fluted side sheet, either of stainless steel or aluminum. No satisfactory scheme has yet been devised to insure that moisture or corrosive elements will be completely excluded from the area between the fluting and the side sheet of the car. The trend in design of window openings and the windows themselves is encouraging. In the past one of the greatest sources of corrosion has been that the window opening has never been properly sealed. Air conditioning has made possible the fixed window. Even the first design of fixed window was not consummated with the idea of eliminating the possibility of moisture getting inside the side sheets and between the various parts of the body. However, the introduction of molded rubber and the latest type of glass now make it possible to produce a moisture-proof window opening. There seems to be no longer any necessity for a window frame. The window opening can be formed from the side sheet and the glass set in a molded rubber insert which will not only seal water from entering around the side sheets, but also around the glass. Available materials for insulation which will prevent the condensation of moisture within the car walls and roof construction should materially eliminate corrosion damage at these locations.

Tile or plastic floors which seal the moisture from the floor sub-assembly should be a part of any passenger car construction detail. Battery boxes, which formerly deteriorated in a very short time, through the use of proper interior coating and grating floors

can be protected against the accumulation of acid-producing residue and be made to last the life of the car.

The selection of steam pipe insulation which will not hold condensation in contact with the pipe will materially lengthen the life of the pipe itself. Due consideration to the location of drains and refuse disposal traps to prevent the deposits making these drains and traps vulnerable is essential.

All steps which should be taken to minimize corrosion through proper equipment design have not been outlined; only the trends and fields for endeavor have been pointed out. Proper design, however, is not the end of the problem. Proper maintenance and servicing are perhaps just as essential.

Maintenance Should Include Corrosion Protection

Features of maintenance that enter into this problem begin at the rail line and end at the peak of the roof of many cars. Corrosion of journal and bearing parts may begin to be detrimental as soon as the parts are machined. It is essential that they be properly and completely protected at once. Friction-bearing corrosion, although not evident to any great extent, is responsible for many hot bearings. The selection and proper use of protective materials before the wheels are applied should not be overlooked. In the case of stored equipment, which always happens in times of slack business, both roller and friction journal bearing parts should be protected by seeing that lubrication is proper and that the cars are moved occasionally to prevent acceleration of corrosion damage which might otherwise take place.

Brake rigging and spring rigging may not show evidence of corrosion damage to the casual observer but there is no question that the lack of proper lubrication and the presence of corrosion causes abnormal wear of the pins and bushings. Truck center plates if not properly lubricated are subjected to abnormal wear because of corrosion. Inability of the car to conform to track curvature is just one of the results, sometimes a serious one, from this type of corrosion.

Parts exposed to battery acid and battery boxes, to say nothing of the batteries themselves, will be less susceptible to corrosion if the box is flushed out at satisfactory intervals. On some types of cars corrosion through improper maintenance will result in serious damage to underframe, center stills, cross bearers, etc. One example of this would be the failure on the part of the maintaining shop to properly seal the center sill hoods on a hopper car so that the lading, when an opening is left, will not sift down and build up on top of the center sill.

Another typical example of improper maintenance, inviting corrosion damage, was observed recently where a lot of composite gondolas were receiving new sides and floors, steel being substituted for wood. As the job was done, an opening some ¾-inch x 1-inch remained between the floor and the side sheets. It goes without saying that within a short time the supporting angles of the side sheets and the floor would be ruined. This is the type of thing that maintenance men must be ever on the alert to avoid, remembering that a small saving in the first cost may result in far greater eventual costs. Figure 14 illustrates the job as it was designed and Figure 15 the improvement which was submitted.

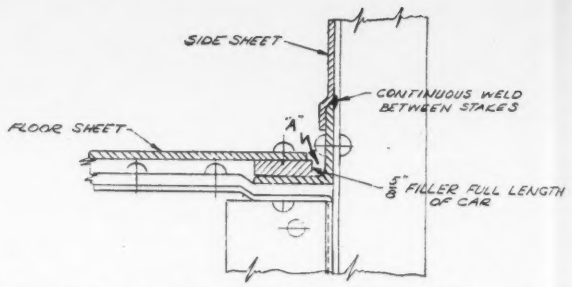

Figure 14—Poor design at floor and side sheets. Point "A" is vulnerable to active corrosion attack.

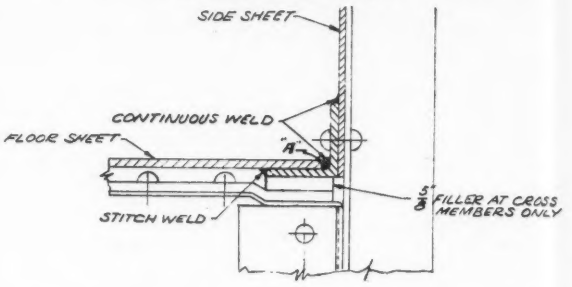

Figure 15—Improved design to minimize corrosion at point "A."

Exterior Cleaning Must Be Watched

Among maintenance practices most often leading to corrosion damage is the cleaning of exteriors of passenger equipment cars. There are many cleaning agents on the market. Most of these if used properly are of such a nature that they will not cause corrosion. On the other hand, some are not properly inhibited. Unless properly supervised and continually policed, the mixing of properly inhibted cleaning agents by indifferent or insufficiently trained employes may result in cars being cleaned with a chemical solution which not only will ruin the paint, but also will work behind such vulnerable parts as fluted side sheets and bring about thousands of dollars of damage before it is discovered. While the introduction of the mechanical washer has, on the one hand, helped this situation because cars are washed at fewer locations, it has on the other hand, created a situation which might be more detrimental because many more cars will be washed at one location than when manual washing is done; and, if an improper solution is used over only a few days' time, the damage resulting would be greater than would be the case otherwise. The same general situation prevails where cleaning of the interiors of cars is concerned. Many cleaners are available for this purpose which are harmless (if mixed in the proper proportions) to the generally used paint schemes, but the mixing of these cleaners if not properly supervised may result in gradual deterioration of the interior finish, which would, of course, be nothing less than corrosion damage.

Steel and Aluminum Roofs Need Protection

When all passenger car roofs were either painted black or black car cement was used on them, it was fairly easy to decide when the paint needed renewing and regular programs were set up to take care of this. Consequently leaks seldom developed which allowed moisture to enter the car through the roof. When stainless steel or aluminum roof construction was substituted and no painting was required or desired, it might naturally be assumed that as far as roof leakage was concerned the problem was solved. This, however, has proved not to be true. The very nature of these materials is such that, unless well reinforced, they will not support employes walking over the top of the roof without fracturing. In some instances, where these fractures have developed and before they were discovered, large quantities of moisture entered through them and untold damage resulted.

In the freight car repair yard where minor repairs are the rule, very little consideration has ever been given to the application of patches or part side sheets in such a manner as to minimize the possibility of corrosion. A portable electric welder is now generally a tool found in all yards. Its proper use will economically insure that patch edges where moisture might enter are seal-welded at critical locations to satisfactorily prevent corrosion. Even when patches are riveted on or when new rivets are applied in new locations carelessness invites corrosion. Unless properly policed and instructed, men removing old rivets burn too large a hole in the sheet or shape so that the new rivet will not properly fill the hole. Or no attempt is made to use a rivet of proper size and the rivet head, though well formed, will not seal the opening. Even if it does, it will not be tight for long and moisture enters these critical areas. Unless the supervisor is always on the job, the workmen will do a sloppy job of holding on and produce only a part of a rivet head and leave an opening that will allow water to drain into the areas where corrosion will immediately result.

All of these corrosion preventing design and maintenance problems, together with many others which have not been mentioned, must be approached seriously and intelligently. If they are, there is no doubt that instead of 28.9 percent of the maintenance dollar being spent to prevent corrosion on passenger cars and 33.5 percent spent to prevent corrosion on freight cars, these figures can be reduced to 10 and 15 percent, respectively, and in the end American railroads will save on the order of $110,000,000 per year and be equipped with rolling stock of far better availability and much greater service life than is experienced at present.

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Stainless Steels for the Bottoms of Tanks Containing Sour Crude Oil*

By C. P. LARRABEE and W. F. ROGERS

Introduction

THE CORROSION of the bottoms of steel storage tanks containing sour crude oil is a problem that has confronted the oil industry for many years. This type of corrosion is caused by the sulfide-bearing salt water that separates from the crude oil and rapidly attacks plain carbon steel. Although coatings that prevent salt water corrosion of steel have been developed, these coatings may contain pin holes or may be damaged during erection of the tanks; thus, localized corrosion may occur and eventually may cause perforation of the tank bottom.

Experimental Procedure

In an attempt to find a metal that, without the necessity of protection by coatings, would be resistant to this corrosion attack, a test was made in which various grades of stainless steels were exposed to conditions similar to those that exist on the bottoms of crude oil storage tanks. For this test, 3-inch by 4-inch pre-weighed specimens were placed in an insulated frame, shown in Figure 1.

Unwelded specimens of stainless steels Types 304, 316, 316-L (0.03 maximum carbon), 317, 410 and 430 were used, as well as welded specimens of Types 316 Cb, 316-L, and 347. The welds on the specimens of Types 316-L, 316 Cb, and 347 were made with rods of the same materials respectively. For comparison purposes, a specimen of unwelded plain carbon steel also was included. The composition of each material is given in Table I.

Two frames of specimens were installed in the aqueous phase of a gun barrel, which is a tank, in this case of 500-barrel capacity, into which the oil and water mixture produced by a pumping well is accumulated and the major portion of the water separated and discarded. Since this barrel is of wooden construction, the specimens were not in contact with any metallic parts during the exposure. During the test, the temperature of the liquid approximated the atmospheric temperature, which on the average was 80° F. The composition of the water to which the specimens were exposed was:

pH	7.80
Sodium	4225 ppm
Calcium	835 ppm
Magnesium	310 ppm
Bicarbonate	2072 ppm
Chloride	5850 ppm
Sulfate	2500 ppm
H_2S	1714 ppm

* Submitted for publication December 21, 1950.

C. P. LARRABEE—Presently in charge of the laboratory and field corrosion testing work on structural, low alloy and stainless steels for the United States Steel Company. He is a graduate of the University of Maine and was employed by the Research and Development Laboratory of United States Steel after ten years work at the National Bureau of Standards. He is a member of the Board of Directors of NACE representing corporate members.

WALTER F. ROGERS—A native Texan, graduated from the University of Pittsburgh with a chemical engineering degree in 1926. He began work as a chemical engineer for the Gulf Refining Company, Port Arthur, Texas, but transferred to the Gulf Production Company, Houston, in 1927. There he studied oil field and pipe line corrosion problems under a fellowship of the Mellon Institute of Industrial Research. He received the professional degree from Pittsburgh in 1934. In 1948 he was made chief chemist of the Houston Production Division Chemical Laboratory of Gulf.

Abstract

The results of tests made for periods of six months and one year under conditions similar to those existing on the bottoms of tanks containing sour crude oil indicate that the austenitic stainless steels have a satisfactory resistance to corrosion and thus are suitable as constructional materials for the bottoms of sour crude oil storage tanks.

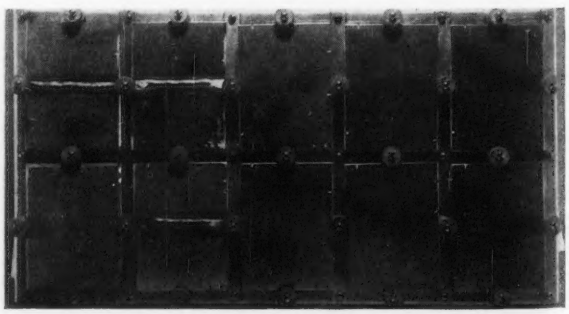

Figure 1—Rack and ten 3-inch x 4-inch specimens before placing in "Gun Barrel." Approximately one-sixth actual size.

TABLE I—Compositions and Corrosion Losses of Steels Exposed to the Salt Water Under "Sour Oil"

A.I.S.I. Type	PERCENT										Condition	Loss of Weight, Grams		Corrosion Rate, Inch per Year	
												YEARS		YEARS	
	C	Mn	P	S	Si	Ni	Cr	Mo	Cb	N_2		0.5	1.0	0.5	1.0
304	0.08	1.34	0.022	0.014	0.33	9.04	18.96	....	....	....	Unwelded	0.001[1]	0.002	Less than 0.0001	
316	0.07	1.52	0.020	0.020	0.35	13.51	17.12	2.50	....	....	Unwelded	0.000	0.002	Less than 0.0001	
316-L[2]	0.019	1.60	0.011	0.010	0.40	13.35	18.34	2.80	....	....	Unwelded	0.000	0.002	Less than 0.0001	
317	0.07	1.60	0.020	0.014	0.35	13.32	18.96	3.30	....	....	Unwelded	0.001	0.008	Less than 0.0001	
316 Cb[3]	0.05	1.95	0.026	0.011	0.27	14.15	18.48	2.40	0.68	....	Welded	0.003	0.003	Less than 0.0001	
316-L[2]	0.027	0.80	0.018	0.008	0.45	13.54	17.68	2.40	....	0.13	Welded	0.002	0.003	Less than 0.0001	
347	0.07	1.48	0.018	0.015	0.28	11.65	18.28	....	0.89	....	Welded	0.003	0.002	Less than 0.0001[4]	
410	0.06	0.41	0.019	0.005	0.45	0.36	12.20	....	....	....	Unwelded	45.0	62.5	0.029	0.020[5]
430	0.10	0.41	0.021	0.014	0.46	0.36	17.0	....	....	....	Unwelded	53.9	51.3	0.034	0.016[5]
C 1020[6]	0.22	0.49	0.018	0.026	0.025	0.02	0.08	....	....	....	Unwelded	17.4	8.1	0.011	0.003

[1] 0.001 gram loss is equivalent to 0.0000003 inch, which varied between 0.0008 and 0.002 inch in depth. [2] 0.03 maximum carbon. [3] Stabilized with columbium. [4] Pits were found [5] Would have been higher except for excessive perforations. See Figure 2. [6] Copper 0.012 percent

Although no measurements were made of oxygen concentration, the water was believed to be practically free of this element.

One frame of specimens was removed after six months and the other after one year. The exposed specimens were examined visually and metallographically and were weighed again after removal of corrosion products in order to determine the amount and nature of corrosion that occurred during exposure.

During exposure, a considerable amount of tarry material from the oil, presumably paraffin wax with some inclusion of iron sulfide, formed on the surfaces of some of the specimens. After exposure this was removed with benzol. The stainless steel specimens were cleaned in nitric acid and the plain carbon steel specimens were cleaned in inhibited hydrochloric acid. After cleaning, the specimens were weighed, and the weight loss of each specimen, together with the corrosion rate calculated from this weight loss, is given in Table I.

Results and Discussion

As may be seen from the data in Table I and in Figure 2, the 0.062-inch-thick specimens of the ferritic stainless steels Types 410 and 430 suffered very severe attack. Indeed, this attack was worse than that suffered by the carbon steel. On the other hand, the austenitic stainless steels Types 304, 316, 316-L, 316 Cb, and 317 were unattacked. The only visible attack on any of the austenitic stainless steels occurred on the specimen of Type 347 that was exposed for one year. Figure 3 shows the appearance of this specimen after cleaning with benzol. The dark areas are spots of red rust, each one surrounding a tiny pit. Metallographic examination disclosed that the depth

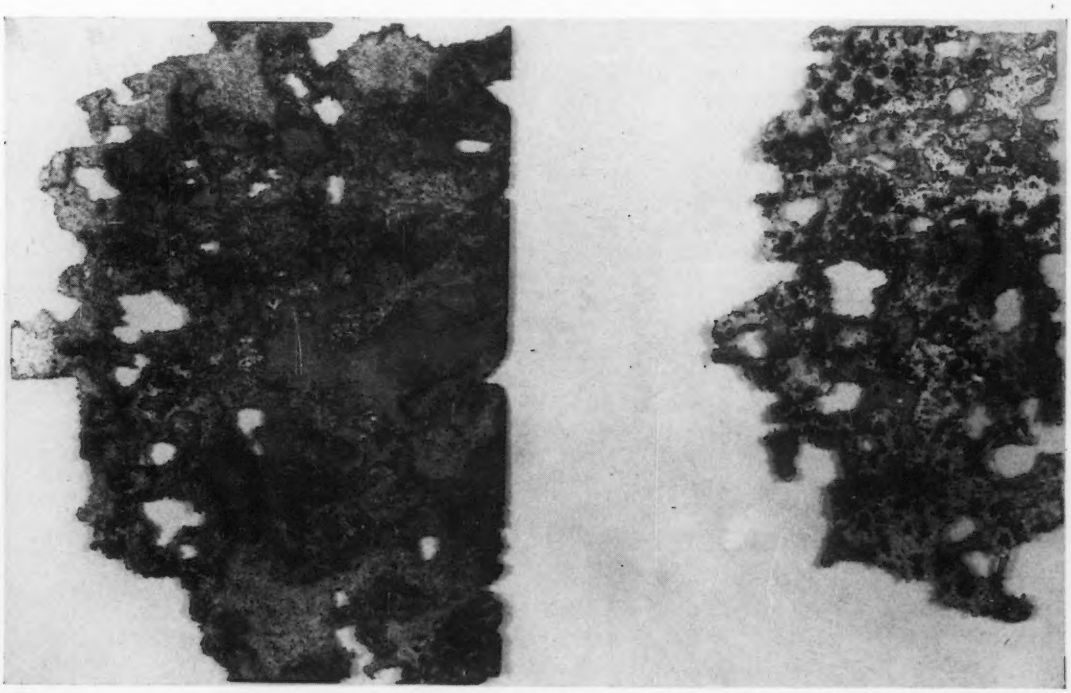

Figure 2—Type 410 (left) and Type 430 (right) specimens after one year's exposure. Plates originally were 0.062-inch thick. Actual size.

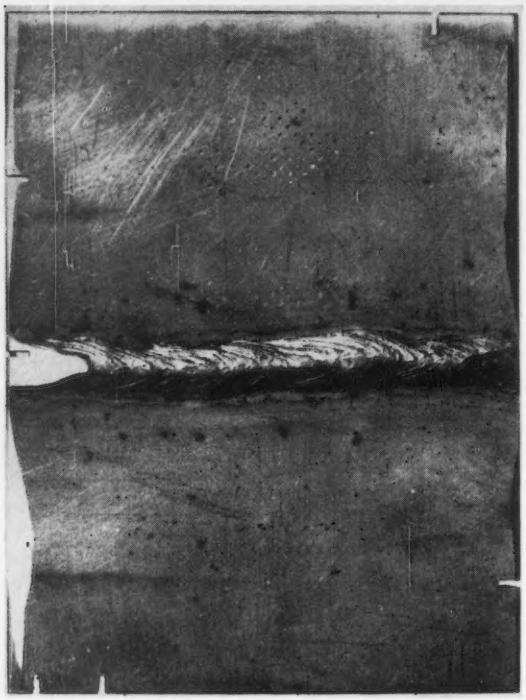

Figure 3—Type 347 specimen after one year's exposure. Many dark spots are rust over a tiny pit. A few dark spots are weld spatter. Actual size.

of these pits varied between 0.0008 and 0.002 inch. No evidence of intergranular attack was found, even in the heat affected zones of the welded specimens.

The considerable differences in the corrosion rates between the structural steel specimens that were exposed for six months and those that were exposed for one year probably were caused by non-uniform testing conditions. Undoubtedly, the tarry coating that was deposited during exposure lowered the corrosion rate of the carbon steel. The thickness of this tarry coating and, therefore, its effectiveness in reducing corrosion increased with increasing time of exposure. At present, no explanation can be offered as to why this coating "protected" the specimens of carbon steel but not those of the two ferritic stainless steels.

Conclusions

The results of this test indicate that the austenitic stainless steels possess satisfactory resistance to corrosive conditions similar to those that exist on the bottoms of sour crude oil storage tanks. Although only one grade of austenitic stainless steel exhibited a susceptibility to a pitting type of attack in this test, other grades also may have developed pits if longer exposure times had been used or if larger specimens had been tested. This is so because the probability of pitting increases with increasing area of steel being exposed and also with increasing time of exposure.

Experience, as well as the results of laboratory investigations, indicate that the molybdenum-containing grades of stainless steels Types 316, 316-L, 316 Cb, and 317 possess more resistance to pitting corrosion than do the non-molybdenum stainless steels. Because of this, these molybdenum-containing stainless steels probably would be the least liable to pitting attack when on the bottoms of sour crude oil storage tanks.

Publication 51-2

Materials of Construction for Handling Sulfuric Acid

TP-5A – Materials, Handling and Manufacturing Sulfuric Acid*

By SPENCER W. SHEPARD*

Abstract

Sulfuric acid has corroded more metal both intentionally and unintentionally than all other commercial acids combined. Application of some of the fundamental factors that govern corrosion rates will minimize attack in many cases. Inhibitors will stifle attack in others. Some of the recently developed organic materials are practically inert over wide concentrations. With the right material of construction in the right place most sulfuric acid corrosion problems can be practically eliminated.

THERE ARE quite a number of materials of construction that have considerable resistance to sulfuric acid over a rather wide range of concentrations and temperatures that can replace materials customarily used.

Most of the recent improvement has been in the field of organic materials such as plastics, elastomers and non-metallic materials of construction. These materials have been used by themselves and in combination with the other more conventional materials of construction to add strength or protection under certain conditions.

Natural and Synthetic Elastomers

Crude rubber linings have been used for many years to handle sulfuric acid at temperatures up to 150° F in concentrations ranging up to 50 percent. They have also been used as a diaphragm behind acid resistant masonry to handle acid of higher concentrations and at higher temperatures. The Neoprene and butyl synthetic elastomers can handle slightly higher concentrations of sulfuric acid and at somewhat higher temperatures than natural rubber. Other similar materials that may be used by themselves or as a diaphragm behind acid resistant masonry are Pyroflex, Saran linings, Tygon or other vinyl linings and polyethylene applied as sheets or flame sprayed. These materials are also available as linings for pipes, liners for Saunders-type valves, as hose that can be used in pinch valves and in forms that can be applied to stacks, duct work, centrifuge baskets and other process equipment. Natural rubber and Neoprene are available as emulsions or dissolved in solvents so they may be applied as protective coatings along with an accelerator that will allow them to vulcanize at room temperature or slightly elevated temperatures. These linings have good adhesion and very good stability in the presence of dilute sulfuric acid.

Lead

Lead has been used for many years for these and similar applications. Lead is quite resistant to sulfuric acid at all concentrations up to around 90 percent at room temperature and has good resistance at the boiling point of sulfuric acid to about 50 percent. Its physical properties are poor. It is very heavy and has poor strength, particularly at elevated temperatures. It tends to fail by alligator cracking when stressed. This may be minimized by having the lead homogeneously bonded to steel, but this is an expensive process that requires much high skilled labor. The corrosion attack on lead is increased by some of the impurities commonly associated with sulfuric acid in the process industries, such as chlorides and nitric acid. Most of the organic materials that have been mentioned are not affected by chlorides or hydrochloric acid in the sulfuric. Some of them have fair resistance to small quantities of nitric acid that frequently occur in sulfuric acid.

Silicate Cements

For many years silicate cements have been used with acid resistant brick, with and without some of these diaphragm materials, to handle sulfuric acid. This cement is quite resistant to the higher concentrations of sulfuric acid but is attacked by dilute sulfuric and may be leached out when the equipment is washed or when it is idle and very dilute solutions may be present. This cement has been replaced to a considerable extent with the phenol-formaldehyde or furane based resinous cements. These cements are somewhat easier to apply, set up more rapidly, have better physical properties and are not leached out by dilute acid. However, they will not withstand elevated temperatures at very high acid concentrations successfully resisted by the silicates.

Furane Base Materials

There has been a considerable development in the last few years in the direction of using these cements, and particularly the furane base cements, in monolithic structures. The Maurice A. Knight Company

* A report of National Association of Corrosion Engineers' Technical Practices Committee 5A—Materials for Handling and Manufacturing Sulfuric Acid. Prepared for and presented at the NACE Seventh Annual Conference and Exhibition, New York, N. Y., March 13-16, 1951, by S. W. Shepard, Chairman TP-5A.

* Materials engineer for the American Cyanamid Company, 30 Rockefeller Plaza, New York, N. Y.

have developed a furane resin, which they call "Permanite," for pipe duct work, towers, pans, etc. The Haveg Company have developed their furane resin, which they call "Haveg 60," reinforced with asbestos in reaction valves, tanks, pumps, valve bodies, pipe ducts, etc. These resins have also been used quite successfully when applied with alternate layers of glass cloth to cover steel and wood agitators, line wood tubs and many other similar applications where sulfuric acid is handled.

Phenol-Formaldehydes

The phenol-formaldehyde coatings, such as Heresite, have been widely used for lining steel equipment handling sulfuric acid in a wide range of concentrations. One of their most interesting uses has been as liners for storage tanks and tank cars handling battery acids or other acids that must not be contaminated with metal salts.

Protective coatings for structural steel adjacent to process equipment have been developed out of many of these organic materials and have been most successful. The resistance of these protective coatings to spills of sulfuric acid or intermittent contact with sulfuric acid is as dependent upon formulation, choice of pigments, plasticizer, solvents and application as on the particular resin used. Actual test exposure of the protective coating is the best guide in securing satisfactory information on the relative resistance of protective coatings.

Molded and Laminated Structures

Some of these resins have also been used in the molded and laminated condition for making tote boxes, fume hoods, filter plate press and frames and filter media for handling sulfuric acid solutions below about 30 percent. Some of these resins, particularly the furane resins and polyester resins, have had novel uses as reinforcing agents for materials that have good resistance to sulfuric acid but are fragile. These resins are applied along with glass cloth as an armor over porcelain, quartz and graphite pipe, valves and tower members. This innovation has allowed the use of these materials where they might be subjected to mechanical shock, thermal shock or internal pressures where they formerly would not have been acceptable.

Field Connections Possible

There have been many improvements in the technique of handling these materials that has tended to make them more dependable than they were when they were first introduced. Among these improvements might be listed the use of Saran lined steel pipe and the techniques that have been developed for making good field connections. Polyethylene and some of the polyvinyl resins can be field-welded to make self-supporting structures that will withstand most dilute sulfuric acid conditions.

Wood has been impregnated with the phenol-formaldehyde and furfuryl alcohol type resins so that it is more resistant to sulfuric acid and has better physical properties for some purposes.

Polyfluorethylene Applications

Teflon and other polyfluorethylene resins have made quite a place for themselves as valve components, gaskets and packing, handling acids of all strengths. Teflon has done a remarkable job as valve stem packing. The Alloy Steel Products Company has also been making valve plug inserts and seats of Teflon. The Duriron Company has developed a real improvement in plug cocks through the use of a Teflon shroud that fits over the plug separating the Durimet 20 plug from the Durimet 20 body, acting as a lubricant. American Cyanamid Co. has had valves in strong sulfuric acid service for about eight months that are still functioning very well. It is possible that this device might also make cast iron plug cocks more acceptable for sulfuric acid service.

Fiber Conduit

For handling 10 to 15 percent sulfuric acid solutions at temperatures up to 130° F, Orangeburg fiber and Bermico fiber conduit have proved quite successful in effluent disposal lines. These are made of asphalt and wood fiber composite. It is quite economical, easy to lay and has proved itself for many years in all kinds of soil conditions.

Other non-metallic materials of construction successfully used are carbon or graphite, glass, porcelain or stoneware. These materials have been made into a wide variety of process equipment such as pipes, pumps, reaction vessels, towers, etc. and have outstanding resistance to acids other than hydrofluoric over a wide range of temperatures. Glass-lined steel equipment has been used in many acid processes such as sulfonations, chlorinations, etc.

Vinyl Filter Media

One of the vinyl resins in fiber form has been used for filter media in handling sulfuric acid solutions quite successfully. Saran and Fiber A have also been used with some success as filter media for sulfuric acid.

Some of the silicone resins have considerable resistance to sulfuric acid. Silastic 180 and 181 have good resistance to sulfuric acid up to 30 percent and temperatures as high as 100° C. They are not resistant to concentrated sulfuric acid, even at room temperatures.

Uscolite, a thermoplastic of the U. S. Rubber Company, has shown good physical properties and good resistance to sulfuric acid in concentrations up to 25 percent at room temperature.

For some specialty items, such as porous filter media, alundum has stood up very well.

Metallic Materials of Construction

Aluminum has fairly good resistance to very dilute sulfuric acid and quite concentrated sulfuric acid. It has been used successfully in fume duct handling SO_2 and SO_3 mists at atmospheric temperatures. It has also been used to a limited extent in handling concentrated sulfuric acid and oleum at moderate temperatures. As a metallized deposit it has shown some promise in protecting steel storage tanks from vapor phase corrosion.

Iron and Steel

Cast iron and steel have been used in great quantities for handling strong sulfuric acid and could probably be used more widely than they are if their limitations were recognized and a real attempt made to design away from their weaknesses. The corrosion rates are sufficiently low for room temperature use of cast iron and steel in sulfuric acid at concentrations from about 60 percent up to 100 percent. However, they are commonly used only in the range of about 80 percent to 100 percent largely because of the possibilities of dilution and subsequent vigorous corrosion. Cast iron and steel depend for their corrosion resistance to sulfuric acid on film formation on the surface. As long as this film is kept intact and acids are actually kept at high strengths, the films on cast iron and steel are quite stable and the corrosion rates are low. However, when these films are abraded off or weakened, corrosion can proceed quite rapidly.

Considerable difficulty has been encountered in steel storage tanks and steel drums storing strong sulfuric acid. When precautions are not taken to allow for the escape of the hydrogen generated, considerable pressure can develop. This may be shown by Figures 1 and 2. Figure 1 shows the results of a test where a 55-gallon sulfuric acid drum was kept at about 40° C containing 50 gallons of 93 percent sulfuric acid. It was fitted with a pressure gauge. The chart indicates that the pressure reached 3 lb. per square inch in about 60 hours. In another similar test the drum was found to develop pressures up to as high as 15 lb. per square inch in 30 days.

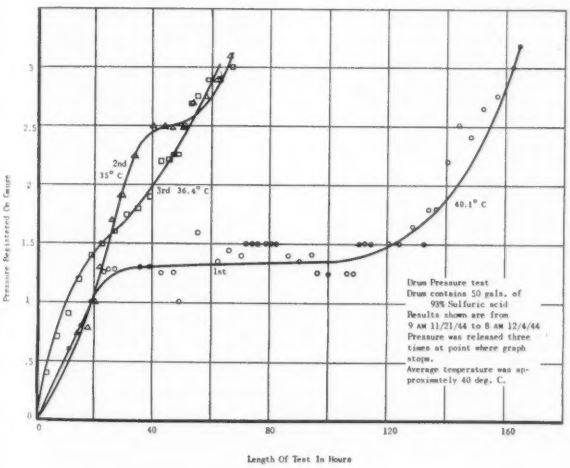
2nd 35° C
3rd 36.4° C
40.1° C
1st
Drum Pressure test
Drum contains 50 gals. of 93% Sulfuric acid
Results shown are from 9 AM 11/21/44 to 8 AM 12/4/44
Pressure was released three times at point where graph stops.
Average temperature was approximately 40 deg. C.
Length Of Test In Hours

Figure 1

The most common difficulty that has been encountered with sulfuric acid storage tanks has been vapor phase corrosion. Wet air enters the tank as it is emptied, the moisture is absorbed by the film of sulfuric acid on the walls and so dilutes it that the steel corrodes rapidly. The life of these tanks can be extended considerably if a thicker shell section is used in the top to allow more wastage, or if the tanks are designed so they can be turned 180°, so that a comparatively unattacked surface can again be exposed to the vapor phase corrosion. This vapor phase corrosion is also accelerated by the high temperatures developed during the day by direct exposure to the sun. This condition can be alleviated somewhat by applying a reflective finish to the outside, insulating the top part of the tank or building a shed over it. There is an indication that the application of a phenol-formaldehyde protective coating in the vapor phase might be helpful and the use of a vapor phase inhibitor is also being investigated.

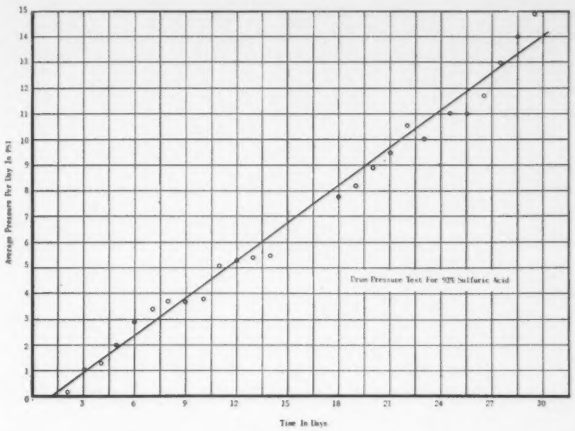

Figure 2

Cast iron has excellent resistance to concentrated sulfuric acid but its use has been avoided in acid containing any appreciable amount of free SO_3. It has been found that this SO_3 combines with silicon, resulting in high stresses and cracking of the cast iron and in some cases this cracking takes place with explosive violence. By purchasing dense, close grained cast iron with a maximum of 1 percent silicon American Cyanamid Company has used cast iron sulfonators with oleum for many years with no sign of cracking. They have been used in concentrations of free SO_3 that are known to be very corrosive to steel. The corrosion rate of the cast iron has not proved to be excessive.

Corrosion Inhibitors

Cast iron and steel are not commonly used as materials of construction for handling dilute sulfuric acid. However, there are many organic materials that act as corrosion inhibitors which permit the use of steel with useably low corrosion rates. American Cyanamid Company has been adding organic inhibitors to sulfuric acid solutions of from 5 to 15 percent at room temperature to 70° C, utilizing two-tenths percent organic inhibitor. Mobile pickling equipment using these as pickling acids to remove scale and rust from heat exchange equipment is in service. The inhibitor used most frequently for sulfuric acid has been benzothiazole.

There are many organic inhibitors of corrosion. Those particularly effective in reducing corrosion on steel in sulfuric acid are organic amines, aldehydes and sulfur compounds such as mercaptans and urea derivatives. The compound must be soluble to about 0.1 percent or be peptized. The efficiencies of these inhibitors are quite high at temperatures below 70° C. Compounds of arsenic and antimony have been successfully used as inorganic corrosion inhibitors.

High Silicon Cast Irons

Cast iron containing 14.25 to 15 percent silicon has been widely used for handling sulfuric acid. Where chlorides may also be present, 3 percent molybdenum is added to increase the resistance to hydrochloric acid. These materials have been used to handle sulfuric acid at all temperatures and at all concentrations. They are somewhat fragile and may be broken by thermal and mechanical shock, but when properly designed and properly used give excellent service.

Stainless Steel

The stainless steels have been used in increasing quantity to handle sulfuric acid largely because they are less likely to contaminate the acid and because they do not sulfate as readily as iron and steel. However, they have to be used with considerable caution as their corrosion rate is low only over limited concentrations and they tend to be either very good or very poor. Limiting concentrations at which the various AISI types of stainless steel may be successfully used for handling sulfuric acid are shown in Table I.

TABLE I

A.I.S.I. Stainless Steel	Temp.	Acid Concentrations
Types 430, 302, 303, 304, 321, 347 Types 309, 310, 446 Types 316, 317	Room	Below .5% and above 90% Below 5% and above 90% Below 20% and above 90%
Types 430, 302, 303, 304, 321, 347 Types 309, 310, 446 Types 316, 317	Below 150° F.	Below .1% and above 95% Below 1% and above 95% Below 5% and above 95%
Types 309, 310, 446 Types 316, 317	Around 200° F.	Below .01% Below .5%

Stainless alloys containing both molybdenum and copper, such as Durimet 20 and Worthite, are useful over a much wider range of temperatures and concentrations. At room temperature they can be used at any strength below 95 percent; at 150° F below 70 percent and at 290° F below 0.1 percent. With any of the stainless steels the presence of oxidizing agents is generally helpful. The presence of halogen compounds, particularly under reducing conditions, is particularly undesirable.

Nickel and Its Alloys

Nickel, Monel, Inconel and Ni-Resist are used at low and moderate temperatures with dilute sulfuric acid. Nickel, Monel and Ni-Resist are most resistant when reducing conditions prevail and Inconel is more resistant under oxidizing conditions. These materials also tend to be cathodic to steel so that they will receive some protection in bi-metallic systems when steel or cast iron are present.

Hastelloys and Chlorimets

These materials are used for handling sulfuric acid under conditions that are considered severe for most other materials of construction, such as high temperatures at high concentrations, high fluid velocities and where mild abrasives may be present.

Precious Metals

Tantalum and gold are not attacked by dilute sulfuric acid at any temperature and have excellent corrosion rates in concentrated acids at temperatures somewhat over 300° F. Free SO_3 in fuming sulfuric acid is destructive to tantalum. Gold hardened with platinum has been used for sulfuric acid concentrator tubes where it is important to secure concentrated acid free from iron or other metallic contaminants.

(Author's Note: There has been so much sulfuric acid used under so many different operating conditions that a wealth of information should be available. However, it is surprisingly difficult to obtain actual plant corrosion rates. Sub-Committee TP5-A would be most grateful for any such information.)

Topic of the Month

Figure 1—Synthetic elastomer applied successfully to irregularly shaped tank and structural protrusions.

Synthetic Elastomer Linings Prove Economical in Kraft Bleaching Unit

By KEN D. GROVES*

AFTER TWENTY MONTHS' service as a lining in a pipe handling Kraft stock (5 percent pulp) mixed with a calcium hypochlorite solution (0.3 lb per gallon available CL_2) in a large Wisconsin paper mill, a synthetic elastomer* lining shows no sign of deterioration. The stock and bleach solution are mixed continuously while in the 18-inch x 40-foot fabricated mild steel pipe at a rate of 500 gallons a minute.

This lined pipe replaced a stainless steel pipe which became badly pitted within six to eight months. Maximum service life of the stainless steel pipe was 12 to 14 months while a June 1951 inspection of the lined pipe indicated a minimum service life of two years.

Economics Are Sound

In addition to the advantage of uninterrupted service the economics of the installation have proved sound. Initial cost of the elastomer lined pipe was 60 to 70 percent of the original stainless steel installation. With a projected service life of 24 months the cost per year of the lined pipe would be less than 35 percent of the original material. Since there was no evidence of deterioration at 20 months the actual expected service life of the lined pipe is indefinite and the cost comparison better proportionately.

A drawing of the lined pipe installation may be seen as Figure 2.

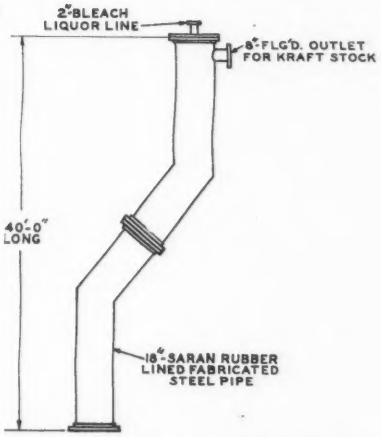

Figure 2—Diagram of Kraft pulp and bleaching solution mixing pipe.

Figure 1 shows the flexibility of the material and how well it can be applied to irregular surfaces.

Easily Applied in Field

Applied in a manner similar to that used for rubber linings and with the same type tools, the material is supplied in standard sheets 3 by 11 feet and in thicknesses of ⅛ and 3/16-inch. The large sheets, manufactured to minimize porosity can be applied in the field as easily as in the applicator's plant. Curing is effected at relatively low temperatures together with a weak ammonia solution which is heated to temperatures between 40 and 70 degrees C, dependent on curing time desired. Expensive stationary curing equipment is unnecessary.

Repairs to damaged lining can be made quickly in the field and equipment returned to service immediately after the lining is repaired.

Physical Properties

Some of the physical properties of the material are:

Tensile strength, psi.....2000-2500
Tear resistance.....150-400 lb/in
Abrasion resistance.....Excellent
Flammability ....Self-extinguishing
Temperature: To 167 degrees intermittently or 150 degrees continuously.

Recommended uses in the chemical field include: Acetic acid 10 percent, ammonium nitrate, benzene, calcium chloride, calcium hypochlorite, carbon disulfide, carbon tetrachloride, chlorine water, chromic acid to 30 percent, cupric chloride, copper plating solution, Esso aviation oil No. 100, formaldehyne 38 percent, ferric chloride, ferrous sulfate, hydrochloric acid, hydrofluoric acid to 48 percent, kerosene, lubricating oil, nickel plating solutions, nitric acid 10 percent, phosphoric acid 85 percent, sulfuric acid to 70 percent, sulfurous acid, toluene, zinc chloride.

Not recommended for acetone, ammonium hydroxide, chloroform, methylisobutylketone, perchloroethylene.

* President, Ken Groves, Inc., Chicago, Ill.
** Saran, a synthetic elastomer, an acrylonitrile copolymer of vinylidene chloride manufactured by the Dow Chemical Company.

NACE News

Western Region–ASTM Joint Meeting Scheduled

Eastern Wisconsin Officers Are Named

The new section of NACE organized at Milwaukee has adopted the name "Eastern Wisconsin Section" as indicative of the geographical distribution of its membership. Officers of the section are Harold F. Haase, 2917 West Juneau Ave., chairman, and I. S. Levinson, Ampco Metal, Inc., secretary-treasurer, both of Milwaukee.

Next meeting of the section is scheduled for September.

Detroit Section

J. H. LoPrete, Spray-Coat Engineers, Detroit, has been named secretary of newly-formed Detroit Section, NACE.

Corpus Christi Section

An illustrated lecture on "Corrosion Testing Program for Large Plants" was presented by Clyde W. Day of Celanese Corp. of America, Bishop, Texas, at the June 27 meeting of Corpus Christi Section. The dinner meeting was held at the Princess Louise Hotel with 14 members and 16 guests present.

A letter of appreciation to George A. Mills, who retired from Central Power and Light Company and removed from Corpus Christi, for his work with the National Association of Corrosion Engineers was read and approved.

Sabine-Neches Section

New officers have been elected as follows by Sabine-Neches Section: William B. Cook, Gulf Oil Corp., Port Arthur, Texas, chairman; Christopher A. Murray, Pure Oil Co., Nederland, Texas, vice-chairman; Charles A. Ridenour, Magnolia Petroleum Co., Beaumont, Texas, secretary-treasurer. The new officers take over at once. Richard P. Clarke, Atlantic Refining Co., Port Arthur, was named trustee.

No meeting of the section will be held during the summer, and the first fall meeting is scheduled during September.

Shreveport Section

Shreveport Section held a fish fry on Lake Bistineau June 15 for members and friends. The event included fishing, swimming and an informal program.

HALF-YEAR MEMBERSHIPS

NACE by-laws provide that those applying for Active (individual) Membership in the association subsequent to June 30 shall pay dues of $5 for the remainder of the calendar year.

- **The half-year membership includes issues of CORROSION magazine, July-December inclusive.**

Tulsa Section

W. E. Huddleston of Huddleston Engineering discussed testing pipe line coatings and L. F. Heverly, Great Lakes Pipe Line Co., described his company's extensive testing program at a meeting of Tulsa Section May 28 at Michaelis Cafeteria.

South Central Meeting

The Driscoll Hotel will be headquarters for the South Central Region's 1951 annual meeting at Corpus Christi, Texas, October 17-20.

1952 Conference

The Buccaneer Hotel, Galveston, will be headquarters hotel for the 1952 national meeting of NACE at Galveston, Texas, the association's executive committee decided at a recent meeting in Chicago. The Galvez Hotel previously had been named as headquarters.

Kulman Named

F. E. Kulman of Consolidated Edison Co., New York, has been named co-chairman of Technical Practices Committee 16D replacing A. K. Joecks.

MEMBERSHIP CARDS AVAILABLE

Association members in good standing will be issued on request a membership card in the National Association of Corrosion Engineers. Address requests to A. B. Campbell, Executive Secretary, 919 Milam Building, Houston 2, Texas.

A joint meeting of American Society for Testing Materials and the National Association of Corrosion Engineers' Western Region is scheduled to be held at Los Angeles November 8-9. Technical contributions will be made by members of both organizations and several field trips are being planned.

F. L. LaQue, of The International Nickel Co., Inc., New York, will deliver the 1951 Marburg Lecture at an ASTM dinner meeting at Rodger Young Auditorium November 8.

On the next day a joint symposium on corrosion will be held at the Biltmore Hotel, Fifth and Olive Streets, Los Angeles. NACE will sponsor four technical papers with prepared comments to be followed by informal discussions.

Field trips for inspection of corrosion problems and remedial measures are contemplated as follows: Protective coatings manufacture, processing and application; the LaVerne water softening and treating plant of the Metropolitan Water District of Southern California. If sufficient interest exists additional trips may be made to oil storage and refinery installations of Standard Oil Company of California's El Segundo Refinery and to marine and harbor installations at Los Angeles and Long Beach.

Requests for reservations and accommodations should be sent to: Robert R. Ashline, Chairman Arrangements Committee, 410 Ducommun St., Los Angeles 12, Cal.

NACE Will Participate In Instrument Society's Houston Conference

Two technical papers sponsored by the National Association of Corrosion Engineers will be given at the Sixth National Instrument Conference and Exhibit to be held at Sam Houston Coliseum September 10-14, 1951. Tentative titles of the papers and their authors are "The Corrosion Engineer's Field Instruments," by Marshall E. Parker, and "Instruments Used in the Laboratory Studies of Corrosion Reactions," by M. A. Judah. Mr. Parker is a corrosion engineering consultant and Mr. Judah a member of Central Office staff NACE.

Organizations cooperating with the Instrument Society of America, sponsors of the meeting, will be the American Institute of Physics, American Society of Mechanical Engineers, American Institute of Electrical Engineers, the Institute of Radio Engineers, the Gulf Coast Spectrographic Society and Pipe Liners Club.

Fourth Permian Basin Tour Scheduled Oct. 15-16

The Fourth Permian Basin Corrosion Inspecton tour will be held October 15-16 with activities centered at Odessa. Permian Basin Section NACE sponsors the tour which has been held annually except in 1950. The dates for the tour were set to make possible a week-long swing through the Southwest for those interested who may wish to attend also the South Central Region's annual meeting at Corpus Christi October 18-20.

The 1949 tour attracted men from 18 states, Washington, D. C., and Canada and it is fully expected the 1951 attendance will be equivalent. About 200 are expected to be present.

Inspections Are Key

Actual inspections of field installations including lease and pipeline tanks, flow lines, casing, line pipe, gasoline plant facilities and others are the key activities of the meeting. These trips, made in air-conditioned, chartered busses, are followed by evening sessions at which reports of the day's tours will be given and discussed.

The active Permian Basin petroleum area, which has a wide variety of corrosion problems, offers an exceptional opportunity for inspections of the service life of treated and untreated metal and to determine the effectiveness of inhibitors, coatings and other materials and procedures.

A nationally known figure in corrosion is expected to deliver an address on the closing evening when a Western barbecue will be served by the Odessa Chuck Wagon gang.

Committee Men Named

Lincoln Hotel, Odessa, will be headquarters hotel. Information and registration material may be secured from Corrosion Tour Headquarters, 119 West Third St., Odessa, Texas. The only fee is $15, which covers registration, transportation, evening programs and barbecue and a printed report of the tour.

John Shelton, district manager for National Tank Company at Odessa and Midland, is chairman of the steering committee. Working with him are William R. Crenshaw, Cren-Ray Plastic Products Co., Midland, and Thomas H. Smith, Odessa American Oil Editor.

Reports of the 1949 tour are available from Ollie Bundrant, Western Company, Midland, Texas, at $1 per copy.

Cast-Weld Construction Data Is Published

Data on technical developments in cast-weld construction, are included in a new booklet based on technical papers presented at the Steel Founders' Society of America national technical and operating conference. Copies may be obtained from F. K. Donaldson, Executive Vice-President of the society at 920 Midland Bldg., Cleveland 15, Ohio.

Petroleum Congress Papers Are Offered

Printed copies of papers presented at the Third World Petroleum Congress held at The Hague-Scheveningen, Netherlands, may be obtained by nonmembers of the Congress from the publishers' E. J. Brill, Leyden, Holland. Orders must be received by the publishers before October 1.

Volume VIII—Construction of Equipment and Materials of Construction, consisting of about 250 pages will contain 20 papers on metallurgy, corrosion, pressure apparatus and refinery equipment in general. The price is 27 guilders, plus mailing costs of 1.50 guilders per volume.

Other volumes are being printed covering other material presented at the congress.

Corrosion News Deadline: 10th of Month PRECEDING Date of Issue

What's your Corrosion Problem?

James E. Mavor Company has the men and material to help you solve your corrosion problems, whatever they may be. Men who have spent years in corrosion research and in the development of corrosion prevention products are at your service.

Adequate stocks of proven corrosion prevention products are maintained at Houston.

In addition, the strategically located manufacturing plants of our suppliers assure prompt shipment in any quantities.

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Manufactured at: Houston, Texas Woodward, Ala.; East St. Louis, Ill.; Chicago, Ill.; Follansbee, West Va.; Garwood, N. J.

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BOOK REVIEWS

MATERIALS HANDBOOK. Revised Seventh Edition. By George S. Brady. 913 Pages, 6 x 9 inches, cloth cover. McGraw-Hill Book Co., 327 West 41st St., New York 18, N. Y. Per Copy $8.50.

A reference source designed for purchasing agents, engineers, executives and foremen covering pertinent physical and chemical properties of natural and synthetic materials used by industry including compounds, abrasives, alloys, metals, minerals, woods, fibers, ores, pigments, solvents, plastics and others in understandable, technically accurate language. Numerous charts, maps and tables on world distribution and production of materials, accompanied by interpretations and analyses are included.

This revised edition by George S. Brady, formerly a managing editor of Product Engineering and formerly among other things chief materials consultant to the Office of Civilian Supply and the Board of Economic Warfare, covers 1500 more materials than earlier editions. The material is designed to provide facts to simplify estimating, specifying and purchasing functions. Corrosion-resisting alloys are included, and the corrosion-resistant or corrosion mitigating characteristics of other materials are noted.

PRICE LIST OF AMERICAN STANDARDS. American Standards Association, 70 East 45th St., New York, N. Y. 26 pages. Free.

Contains more than 1180 standard specifications, methods of test, symbols, abbreviations, and includes new standards. A complete set of all standards may be purchased for $280.

FREE ***Reprints While Supply Lasts***

***The Influence of Stress on Corrosion,* by Julius J. Harwood, Office of Naval Research, Washington, D. C. Reprinted from CORROSION, Vol. 6, No. 8 and and 9 (1950). A paper presented at the NACE meeting, St. Louis, Mo., April, 1950.**

Address your request to: Norman E. Hamner, Managing Editor, Corrosion, 919 Milam Bldg., Houston 2, Texas.

Two Metal Powder Standards Are Proposed

Two new tentative standards have been promulgated by the Metal Powder Association. One, designated 14-51T, specifies preferred dimensions and tolerances of oil-impregnated metal powder bearings, lists and specifies dimensions and dimensional tolerances of sintered metal powder oil impregnated bearings of the bronze base and iron base types. The standard is tentative for three years.

The other standard deals with the green strength, applying to the resistance of a pressed compact to abrasion, breakage and spalling due to rough handling and to the forces resulting from plastic deformation of dies and relative die segment movement during the pressing operation. This standard has been designated 15-51T and covers the Rattler and Transverse Rupture tests.

Seagren Appointed

George S. Seagren, Mellon Institute, Pittsburgh, Pa., has replaced R. B. Mears as representative of NACE on the Inter-Society Corrosion Committee. Mr. Seagren also is chairman of Technical Practices Committee TP-6F.

RUSTPROOF WATER

with ODORLESS . . NEUTRAL . . NON-TOXIC . . NON-INFLAMMABLE

IMMUNOL

Makes any kind of water rustproof and at the same time makes an efficient, neutral solvent which actually costs less as a finished solution than kerosene or mineral solvents.

IMMUNOL leaves a non-oily, invisible, non-tacky film of rust protection that will last indefinitely unless washed off and can be painted or lacquered over without removal. Parts can be left in the solution for days if desired or dipped for only a few moments.

Outstanding for such applications as cleaning ferrous metals; replacing alkalies and solvents; hydrostatic testing; rustproofing wire during processing; preserving bright finishes; preventing plating stains; protecting metal parts wrapped in paper without staining the paper, etc.

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San Francisco Section Interim Officers Named

Interim officers were appointed for San Francisco Bay Area Section at a June 6 meeting at El Jardin Restaurant, San Francisco, following the resignation of Chairman Robert J. King. David Hendrickson, East Bay Municipal Utility District, Oakland, formerly vice-chairman, became chairman and George Werks, Union Oil Company of California, Oleum, Cal., became vice-chairman. Charles E. Haney remained secretary-treasurer. Mr. King has been transferred to California Refining Co., Barber, N. J.

The technical program consisted of a talk on "Metal Protective Paint," by P. F. Bradley, head of the Organic Application Department, Shell Development Co., Emeryville, Cal. There were present 46 members and guests to hear Mr. Bradley cover well in the limited time available the many-sided topic. He covered types of organic-metal coating, methods of manufacture, characteristics of films, effect of varying composition, specifications for paints, laboratory equipment for paint testing and new coatings of importance to the corrosion engineers.

Principal points covered were: Linseed oil is not preferred because of poor water resistance, tung oil is somewhat better in water resistance than linseed oil, Brazilian octicica oil is a poor substitute for tung oil because of slow drying, accelerated paint tests are difficult to evaluate in terms of service life.

Resin gives hardness, oil toughness; epon resins are tougher than other paint resins and are more resistant to water and alkalies, epon group plus acid or amine converts to insoluble, infusible form without oxidation or air which permits heavy film thickness with one application and thus more protection, hot dip galvanized coating forms best bond to metal, wash primers (basic zinc chromate-polyvinyl butyral-alcohol solvent 4 parts, 1 part phosphoric acid solution) gives best surface preparation for maximum bond, specifications should include composition, performance required and specific methods of application.

ASTM Meetings

Meetings of the American Society for Testing Materials have been announced as follows:

1952 Spring Meeting and Committee Week, Hotel Statler, Cleveland, Ohio, March 3-7 incl.

1953 Annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J., June 21-25 incl.

1953 Spring Meeting and Committee Week, Statler Hotel, Detroit, Mich., March 2-6 incl.

1954 Annual Meeting and Exhibits, Sherman Hotel, Chicago, Ill., June 13-18 incl.

1954 Spring Meeting and Committee Week, Shoreham Hotel, Washington, D. C., March 1-5 incl.

•

Titanium Research

Monsanto Chemical Company and National Research Corporation, Cambridge, Mass., have entered a joint research agreement whereby new methods will be sought for the production of titanium.

ASTM Awards for Outstanding Papers

The 1951 American Society for Testing Materials annual awards for outstanding technical papers were made during the week of June 18 at the society's annual meeting as follows:

Charles B. Dudley Medal to Professors D. S. Clark and P. E. Duwez of California Institute of Technology.

Richard L. Templin Award to R. L. Templin and W. C. Aber, Aluminum Co. of America.

Sam Tour Award to C. T. Evans, Jr., the Elliott Co., for his paper "Oil Ash Corrosion of Metals at Elevated Temperatures."

Sanford E. Thompson Award to R. C. Mielenz, L. P. Witte and O. J. Glantz, U. S. Bureau of Reclamation.

Among the ten leaders in the field of engineering materials who have rendered outstanding service to ASTM given awards of merit was:

Carl DeWitt Hocker, Associate Professor of Chemistry, Union College, Schenectady, N. Y., for his meritorious service over 25 years on Committee A-5 on Corrosion of Iron and Steel.

Stahl und Eisen

The German magazine "Stahl und Eisen" is being exchanged for Corrosion. The magazine is published by Verein Deutscher Eisenhuttenleute, Bucherei, Dusseldorf, Germany.

World Metal Resources Will Be Discussed

World metal resources will be the principal topic of discussion for more than 500 persons from over 20 countries expected to attend the World Metallurgical Congress to be held in conjunction with the 33rd annual National Metal Congress and Exposition at Detroit, Mich., October 14-19. The conferees are participants in a technical assistance program sponsored by the Economic Cooperation Administration. They are expected to arrive in the United States about September 15 and spend approximately five weeks in the United States touring industrial, government, and educational institutions.

The need for uniform terminology to facilitate exchange in metallurgical information internationally is among the projects to be considered by the Metallurgical Congress.

W. F. Wilson Honored

Warden F. Wilson, general salesmanager of the Lebanon Steel Foundry, Lebanon, Pa., has been elected president of the Alloy Casting Institute. Other officers elected were H. T. Harrison, Duraloy Co., Scottdale, Pa., vice-president; E. A. Schoefer, executive secretary reelected; G. A. Baker, The Duriron Co., Dayton, and J. S. Wooters, General Alloys Co., Boston, were elected to three-year terms as members of the board of directors.

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Approx. Size

Approximately 7/16 inches high, gold, inlaid with bright red enamel background to "NACE" and deep blue enamel background to words "CORROSION CONTROL." Ruby center.

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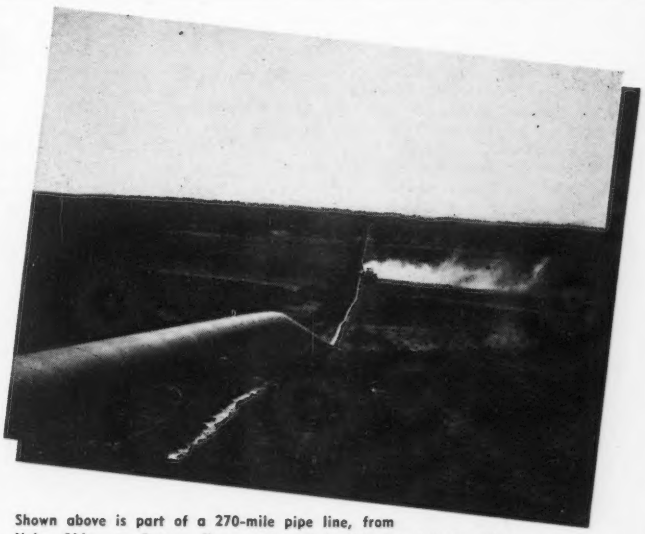
PROVED PROTECTION FOR UNDERGROUND PIPE

The rugged effectiveness of Asbestos Pipe Line Felt in protecting underground pipe coatings has been proved by long-time use.

Nicolet Asbestos Pipe Line Felt is made of high quality asbestos fibers. These strong fibers make Nicolet Felt a positive reinforcement for the enamel and an effective shield against soil stress and all corrosive soil conditions.

Nicolet Felt is not a foreign material in the enamel. It is at the outside, partially imbedded, where it can stop corrosion and damage before it starts.



Shown above is part of a 270-mile pipe line, from Yale, Okla., to Borger, Tex., protected by Nicolet Asbestos Pipe Line Felt. Note the continuous, even application without breaks.

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Corrosion Problems

E. A. TICE, Editor

Corrosion Engineering Section, The International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.

Submit questions and answers for this column in duplicate to the editor. All questions become property of NACE. Questions and Answers may or may not be published under this heading, and may at discretion, be answered by mail directly. Answers to questions are solicited. Authors of questions will remain anonymous to readers while authors of answers may remain anonymous if they request it.

QUESTION

No. 50—A viscous fuel oil, containing about 3 percent sulfur, is to be pumped through a pipe line for a considerable distance. To keep it warm enough to flow, a one-inch steam line handling steam at 300 to 350°F will be installed within the pipe line, which is made of steel.

There may be some caustic soda entrained in the fuel oil. Can steel piping be expected to have satisfactory corrosion resistance for use as the steam line or must an alloy be used? If so, what material is recommended?

ANSWER

The corrosiveness of sulfur-containing oil is a strong function of temperature. For the temperature range specified, 7 to 9 percent Cr steel shows a very good resistance to corrosion in this service. However, it may be economically feasible to use carbon steel, since the cost of chrome steel will be approximately four to five times that of carbon steel.

Any entrained caustic in the oil would neutralize the sulfides to some extent, depending on the concentrations. The acidity of the oil would have to be determined in this case.

For the conditions as stated, and with only the information as given in the question, carbon steel would appear to be the preferable material.

QUESTION

No. 28—What material can be used for air piping in the aeration of sewage containing up to 2000 ppm of organic matter, up to 6 ppm of oxygen, and up to 15 ppm of carbon dioxide?

ANSWER

Provided good circulation is present, air piping for the aeration of sewage containing up to 2000 ppm organic matter, 6 ppm oxygen and 15 ppm carbon dioxide is usually constructed of cast iron or wrought iron, either of which have good service records. Service records for aluminum and steel are not uniformly good. Particular difficulty is experienced when copper-bearing metals are used in conjunction with steel or aluminum and, to a lesser extent, with cast iron or wrought iron. In a few cases, Saran is being used and the experience to date has been good. The same experience can be reported for some cases where plastic-covered steel is used.—W. H. Wisely, Executive Secretary, Federation of Sewage Works Assoc.

QUESTION

No. 89—Is the chemical purity of zinc anodes for sacrificial protection of steel critical, and if so, what are some of the boundary limits for contents of impurities? If secondary zinc metal is suitable, what impurity has the most influence on effective performance of the anode?

ANSWER

The effects of chemical purity of zinc anodes for sacrificial protection of steel is not a clear cut matter. Experiments reported by May, Gordon and Schuldiner on page 158 in the book on "Cathodic Protection A Symposium" by the Electrochemical Society and NACE 1949, indicated that zinc anodes containing lead, cadmium and iron as impurities, would tend to form films of insoluble corrosion products which would reduce their current output in sea water. Wahlquist in *Corrosion*, 1, 119, (1945), observed similar performance in soils where zinc anodes were being used to protect pipe lines. More recently, some tests suggest that lead may be the most important impurity contributing to this failure of zinc anodes to produce current over a long period of time. However, these tests are not yet conclusive. Generally speaking, high purity zinc containing 99.99 percent zinc has proved to be the most reliable composition for zinc galvanic anodes.—T. P. May, The International Nickel Company, New York, New York.

Clippings on Corrosion

Extracted from Current Periodicals

PROTECT HOME SCREENS WITH PROTECTIVE COATINGS

(From Covington, Ky. *Post*, Apr. 28, 1951)

Galvanized screens beginning to rust can be protected by application of screen enamel and bronze or copper screens by applications of spar varnish. The material should be applied with an applicator made of an old piece of carpet to prevent the holes filling up.

•

PLASTIC PIPING USED TO TRANSPORT CORROSIVES

(From Oklahoma City, Okla. *Live Stock News*, May 16, 1951)

Corrosion-resistant plastic piping is being used effectively in chemical and rayon plants, in oil wells and in rural water systems under conditions which would cause metal pipe to corrode in two years, says Dr. G. M. Kline, chief of the plastic section of the National Bureau of Standards.

•

CORROSION CUTS WATER SUPPLY TO TRICKLE

(From Springfield, Mass., Union, June 9, 1951)

Wartime substitution of cement-lined black pipe and brass and bronze connections has resulted in corrosion of interior piping of the Mallary Village Public Housing Authority housing project to the point the water supply has been cut down to a trickle. Repairs to the piping are estimated to cost about $50,000, a report to the PHA in Washington, (owners of the 300-unit project), by John L. Robinson and Harry P. Hogan of the local authority indicates.

•

BRASS PIPE IS USED IN TRAILER HOMES

(From Dodge City, Kan., Globe, June 4, 1951)

At least one manufacturer of trailer houses uses brass piping to avoid corrosion in damp climates.

•

$500,000 CORROSION LOSS SUIT IS FILED

(From Shreveport, La., Times, June 1, 1951)

A damage suit for $500,000 has been filed against the Ethyl Corporation at Baton Rouge, La., by 120 persons who live adjacent to the plant and who allege corrosive acids generated by the plant have deteriorated value of the property, damaged household appliances and automobiles and destroyed resale value of the homes.

The petition charges "when this impregnated salt dust touches vegetation, painted surfaces, chrome, composition roofing and mechanical and household appliances, the acid-impregnated salt dust reacts on the surface and causes a high degree of damage . . . " While the plaintiffs do not seek an injunction, the families have reserved the right to seek an injunction in the event the defendant fails or refuses to eliminate the emission of the nauseous, offensive and destructive vapors.

•

FISHERMEN USING GLASS RODS MORE, WRITER SAYS

(Plainview, Texas, Herald, May 24, 1951)

Glass rods for fishing are practically unbreakable and have the advantage over bamboo that they will not rot and over steel that they will not rust. A novelty when first introduced, the new product became a rage and now is being marketed at prices under competing rods.

•

CORROSION DETECTING INSTRUMENT PATENTED

(From New Orleans, La., Times-Picayune, June 17, 1951)

A patent has been issued to J. Franklin Bayhi, of Tulsa, on a bomb-shaped instrument holding a magnetic scanner. The device indicates corrosion inside and outside of pipe. Bayhi is head of the geophysical department of Carter Oil Co.

•

STAINLESS STEEL BEAKER

(From St. Louis, Mo. *Record*, May 7, 1951)

A new beaker in 100, 1500 and 2000 ml sizes made of stainless steel with insulating fiber handles can be attached to ring stands and promises safety from laboratory accidents with hot corrosive liquids.

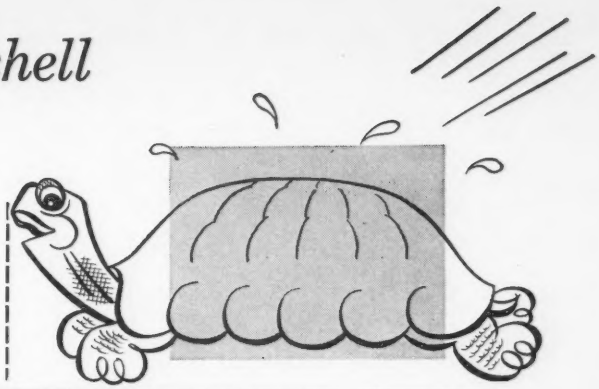
•

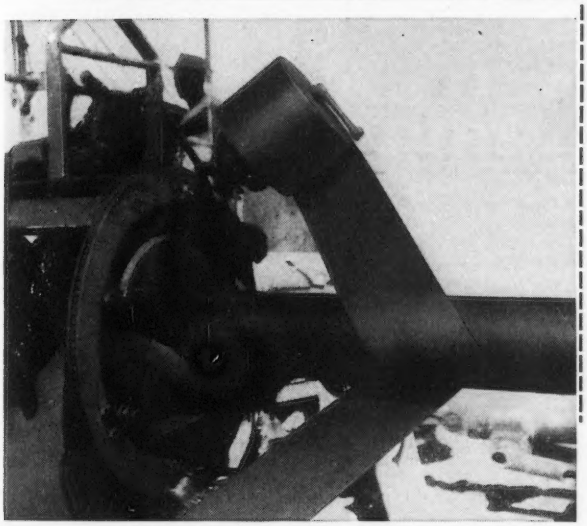
47 CENTS OF FARMERS' REPAIR DOLLAR LAID TO DAMAGE FROM RUST

(From Stigler, Okla. *Tribune*, Apr. 12, 1951)

A prominent farm equipment manufacturer reports that up to 47 cents out of every dollar spent for repairs to farm equipment is due to the ravages of rust, according to Eric Patterson, Farm Supt., State Institute of Applied Agriculture Farmingdale, N. Y.

Like the turtle's tough shell that protects him so well...





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Asbestos Felt protects oil and gas pipe lines

Johns-Manville Asbestos Pipeline Felt now protects more than 100,000 miles of oil and gas pipe lines! *It is the only type of wrapper that has survived over 50 years of service in all types of soils.*

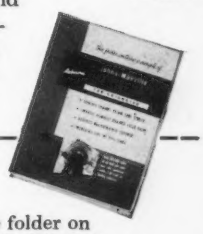
Johns-Manville Asbestos Felt is a sturdy product. It is resistant to rot and decay, and to acid and alkali soils. It has both the thickness and the toughness necessary for shielding pipe line enamels from damaging earth loads and soil stresses. These advantages make it possible for the protective enamel pipe coating to function properly against corrosion.

Johns-Manville Asbestos Felt is flexible. It wraps easily without cracking. It guards enamel from impact damage both during installation of field-wrapped pipe, and during transportation and installation of mill-wrapped pipe.

There are important economic benefits, too! Johns-Manville Asbestos Felt will help add many years to the life of the pipeline and help to keep maintenance costs low.

Johns-Manville Asbestos Pipeline Felt can be had in any width from 2″ to 60″, in any length desired.

For additional information and a sample of Johns-Manville Asbestos Pipeline Felt, simply fill in and mail the coupon provided below.



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First Deliveries of Abstract Cards Scheduled Sept. 1

First deliveries of printed abstract punch cards should be in the mails to subscribers about September 1, according to present plans. Multilith printing plates from which the cards will be printed by Central Office have been prepared and are being completed as rapidly as possible. The large backlog of abstracts that has accumulated since the first of the year and which will be printed on the cards is expected to make the first deliveries of cards to subscribers heavy.

Normal deliveries at the rate of approximately 250 printed cards are expected to be made monthly after the backlog is consumed.

Changes Made In Index

Miss Marguerite Bebbington's abstract committee made several changes in the position of items in the abstract filing system index, which is the basis for the indexing used on the cards. The rationalization of these changes among members of the committee consumed several months of time as did some changes in the formula for applying the random numbers system to the punching and a decision to extend the punching to the third index position instead of to the second only as had been contemplated originally.

Abstract Activities Centralized

All work of the association in connection with abstracting, except the obvious committee functions, now has been centralized at Houston. Much of the editorial and search work formerly had been done by Dr. Ivy M. Parker, editor of Corrosion.

This centralization was necessary because the work done gratuitously by Dr. Parker was becoming too great a burden and because the fruition of the long-time plan to issue the abstract punch cards made location of all abstract work at Houston essential.

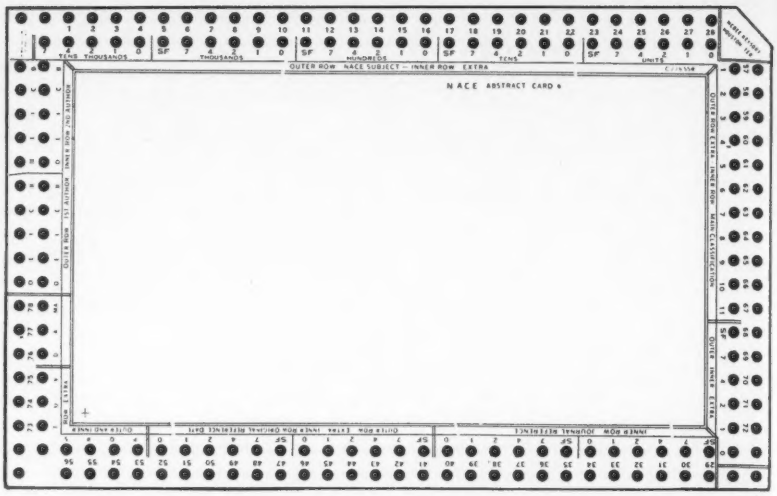
Subscribers to the service will be sent initially several items complementary to the abstract cards. These include a copy of the Abstract Filing System arranged topically, a copy of the filing system index arranged alphabetically with the corresponding random number assignment of each appended. The topical index will permit additional indexing where necessary and the alphabetical arrangement is the key to the random numbers by which the cards are selected.

Random numbers used with the McBee system punch cards are groups of four numbers so distributed that when the selector needles are placed at points corresponding to the numbers only the cards with slots punched at these numbers will fall from the stack. The use of these numbers permits many more items to be selected than would be the case by direct assignment of holes by serial numbers.

Subscribers will receive a general description of the random numbers system used, instructions for operation of the selection system, instructions for indexing additional to that provided by NACE on the cards initially, a manual provided by the McBee company describing the punch cards and illustrating accessories for sorting and filing.

Printed abstract cards will contain the topical number keys to the filing system index and holes to be punched corresponding to these numbers will be indicated on each card. It thus will be possible for inexperienced workers to do the necessary punching.

Space is provided on the card for the convenience of those who wish to add specialized indexing to the NACE system. Those who prefer to use another indexing system entirely may ignore the NACE system and use their own scheme, if they so desire if they prepare the proper templates. Blank punch cards will be available for those who wish to prepare duplicate cards of abstracts.



The NACE Abstract Punch Card reproduced above was designed to permit semi-automatic sorting through use of inexpensive equipment. The abstract, substantially as it appears published elsewhere by the association, will be printed on the interior space of the card.

Master File Plans

Central Office NACE will maintain a master file of abstract cards to which a card will be added for each abstract printed. It is contemplated the first year's issue of cards will consist of about 2000 cards covering literature currently being abstracted and about 500 cards covering literature previously abstracted and published in Corrosion or elsewhere. Each succeeding year's issue will include both current and old abstracts so ultimately by working in both directions a file will be provided covering all available abstracts of corrosion literature.

Ultimately the association may consider offering a search service but no provision has been made yet to provide it nor are any early plans for this service in preparation. In any case the search service would be of limited value until a sufficient number of cards have been accumulated in the NACE file to make the search reasonably conclusive. Should this service be made available later, it will be on a cost-for-time basis.

Subscriptions Necessary

After carefully weighing all alternatives the association decided to offer the card service on the following basis only:

1. All subscriptions must be in advance and for a calendar year.
2. All subscriptions must cover all the cards published. No partial subscriptions are accepted.
3. Subscription costs after the first year will be based on experience in offering the service as NACE is rendering the card service on a cost basis.
4. Abstract cards sent to subscribers will not be punched by the Central Office for classification.

Distributors & Contract Applicators of:

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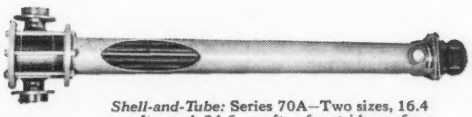
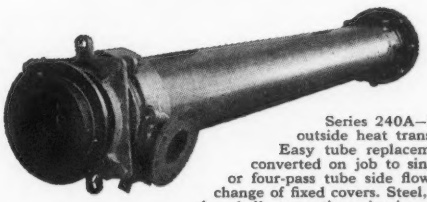
The "Karbate" impervious graphite heat exchangers illustrated are used extensively as boilers, coolers, condensers, vaporizers, evaporators, heaters and absorbers in handling corrosive chemicals, either hot or cold. They *all* can be had in a complete size range. *All of them* offer the following advantages:

- **Highest heat conductivity rate of the practical corrosion-resistant materials.**
- **Highly resistant to corrosion by acids or alkalis, hot or cold.**
- **Freedom from corrosion scale, as compared to metals.**
- **Immune to thermal shock.**
- **No contamination of product.**
- **Strong and easy to install and maintain.**



Shell-and-Tube: Series 70A—Two sizes, 16.4 sq. ft., and 24.6 sq. ft. of outside surface area respectively. Tubes easily replaced in the field. Interchangeable single and double-pass construction.



Series 240A—70.6 feet of outside heat transfer surface. Easy tube replacement. Easily converted on job to single, double, or four-pass tube side flow by simple change of fixed covers. Steel, shell, oversize shell connections, impingement plates and drain and vent plugs integral with shell end castings. Stainless-steel baffles assembled with steel tie rods to form protective cage for tube bundle. Removable "Karbate" tube bundle. Write for catalog sections for S-6690, S-6715 for details of applications, maintenance, sizes and characteristics of these exchangers.

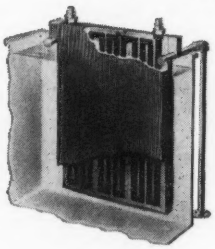
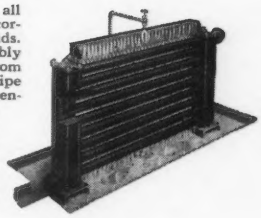
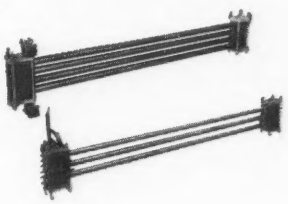


Plate heaters: Used to heat or cool corrosive liquids in tanks and vessels. Compact, completely assembled, easy to put in. Used in pickling, etching, plating and cleaning tanks. Complete size range. Models for horizontal and vertical mounting. Write for catalog section S-6620.

Style FH heat exchangers (Size 1½): Are especially recommended for tanks with solution depths of 16 inches or less. Write for catalog section S-6750.



Cascade coolers: For all cooling jobs involving corrosive gases and liquids. Complete cooler assembly may be made quickly from 4 standard items in 5 pipe sizes. Capacity easily enlarged or reduced by adding or subtracting standard sections. Compact construction to save plant room. No special supporting structure needed. Write for catalog section S-6780.



Concentric Tube exchangers: Available in two types. Series 10A is small, low-priced, gives true counterflow. Exceptionally good for small flow rates at narrow temperature differences . . . Series 20A manufactured with "Karbate" inner and outer piping, and is used to transfer heat between two corrosive fluids. Both have sectional construction, can be added to or subtracted from at will. Sturdy, can be moved from place to place after assembly, adapted to any method of mounting on floor, wall, or ceiling. Write for catalog section S-6670.

The term "Karbate" is a registered trade-mark of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

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Montreal, Toronto, Winnipeg

A full line of "Karbate" impervious graphite pipe and fittings

for conveying corrosive chemicals includes: "Karbate" pumps of advanced design embodying impervious graphite case, impeller, and a rotary seal which eliminates the stuffing box. Pump prices reduced up to 33%. Write for catalog section S-7000 for pipe information, S-7200 for pump information.

Tentative Galveston Program Plans Are Outlined

Technical committee meetings will be held throughout the 1952 conference week, about four daily, distributed to minimize conflicts, the Executive Committee of the National Association of Corrosion Engineers decided at a meeting in Chicago June 15 and 16. The custom of the past two years has been to hold most technical committee meetings on the Monday preceding the opening of the conference.

The Buccaneer Hotel has been designated Convention Headquarters Hotel but both the Buccaneer and Galvez hotels will have registration facilities, it also was decided. There will be no pre-registration in 1952.

Non-technical committees are expected to meet Tuesday forenoon. The general business meeting will be held Tuesday forenoon, 11 to 12:30.

Other decisions were:

Respecting Committees:

1. Technical committees wishing to hold meetings Monday, March 10, may do so.

2. Technical committee meetings may be held daily through the convention week. Careful coordination will be required.

3. No committee meetings will be scheduled during the time of the general business meeting, Tuesday, March 11, 11 to 12:30.

4. Each morning there will be a breakfast for all symposia chairmen and co-chairmen and speakers for that day. This breakfast will be furnished by the association.

5. Non-technical committee meetings will be held Tuesday 9 to 11.

Respecting Exhibitors:

1. Monday, March 10, will be setting up day for exhibitors.

2. Three free registrations will be given to each exhibitor.

Respecting the Technical Program:

1. A General Corrosion Session will be held Tuesday afternoon.

2. There will be two technical symposia each on Wednesday and Thursday mornings and afternoons. Two concurrent round table discussions will be held Friday forenoon. The conference closes Friday noon.

Respecting Registration:

1. Registrations will be taken at both the Buccaneer and Galvez Hotels starting Monday morning, March 10.

2. The Buccaneer Hotel will be Conference headquarters.

3. There will be no pre-registration.

4. Non-member speakers may register without paying a fee.

Miscellaneous Decisions

1. A board of directors' meeting will be held Sunday, March 9. No meeting of the executive committee preceding the board meeting is scheduled.

2. General business meeting will be held Tuesday, 11 to 12:30.

3. Dr. N. E. Berry and A. B. Campbell will arrange non-technical committee meetings schedule.

4. All printing will be handled through NACE Central Office.

By-Laws Are Mailed

Association members have been mailed copies of the articles of organization and the revised by-laws and a copy of the procedure for advancing funds from Central Office to regional divisions and sections and a procedure for annual accounting of funds in the hands of section and region treasuries.

Sections Outside U. S. Authorized for Two Association Regions

Two regions of the National Association of Corrosion Engineers will be expanded to include territory outside the political boundaries of the United States so sections formed in the areas included may be directly affiliated with the association. This decision was among those reached by the NACE executive committee at the Sherman Hotel, Chicago, June 15 and 16. There were present N. E. Berry, M. G. Fontana, R. A. Brannon, Vance A. Jenkins, Frank L. Whitney, Jr., Walter F. Rogers and A. B. Campbell.

North Central Region will be extended to include the Province of Alberta, Canada, and South East Region will be extended to include the Isthmus of Panama. Requests have been received indicating corrosion workers in the areas involved wish to form local organizations.

Corrosion Short Courses

The association will endeavor to arrange, but will not insist on, a provision for larger registration fees for non-members than for members for those attending corrosion short courses at universities and colleges. Furthermore, the executive committee will consider for approval all short courses in which NACE participation is mentioned. The Education Committee's plans and arrangements will be recommendatory.

Section Names Restricted

No local section will be authorized to take the name of an entire state or be designated by name in such a manner to infer state-wide jurisdiction.

Charter or Certificates

The committee favors issuing certificates in recognition of the formation of local sections in a form to be established by the Policy and Planning and Regional Management committees.

Committee Decisions

The committee recommended the Advertising Committee be discontinued and asked for further information respecting the formation of a Public Relations Committee suggested by Norman E. Hamner, managing editor of Corrosion magazine.

Standards Preparation

The committee felt NACE might propose methods of testing for trial use for the purpose of acquiring experience but not resort to the extended formal procedure generally necessary for a standardizing body to follow.

Numerous decisions also were made respecting the 1952 Galveston Conference.

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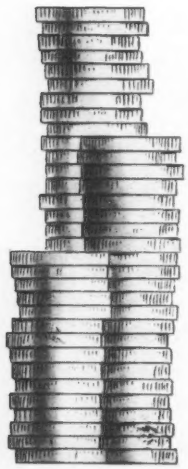
Corrosion mitigation processes and materials are publicized free of charge in CORROSION's "New Products" section. NACE acepts no responsibility for accuracy of performance claims.

PROFITS ARE SAVED NOT MADE



Whether it be a gas or water distribution system, a transmission pipe line, tank bottom, off-shore drilling platform, condenser or water tank, or ship hull, corrosion losses can be stopped—*can* be converted to profits.

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Whether your company has a single tank or thousands of miles of pipe line, you'll find that ERP can help you *save* profits. Write for details without obligation, of course.

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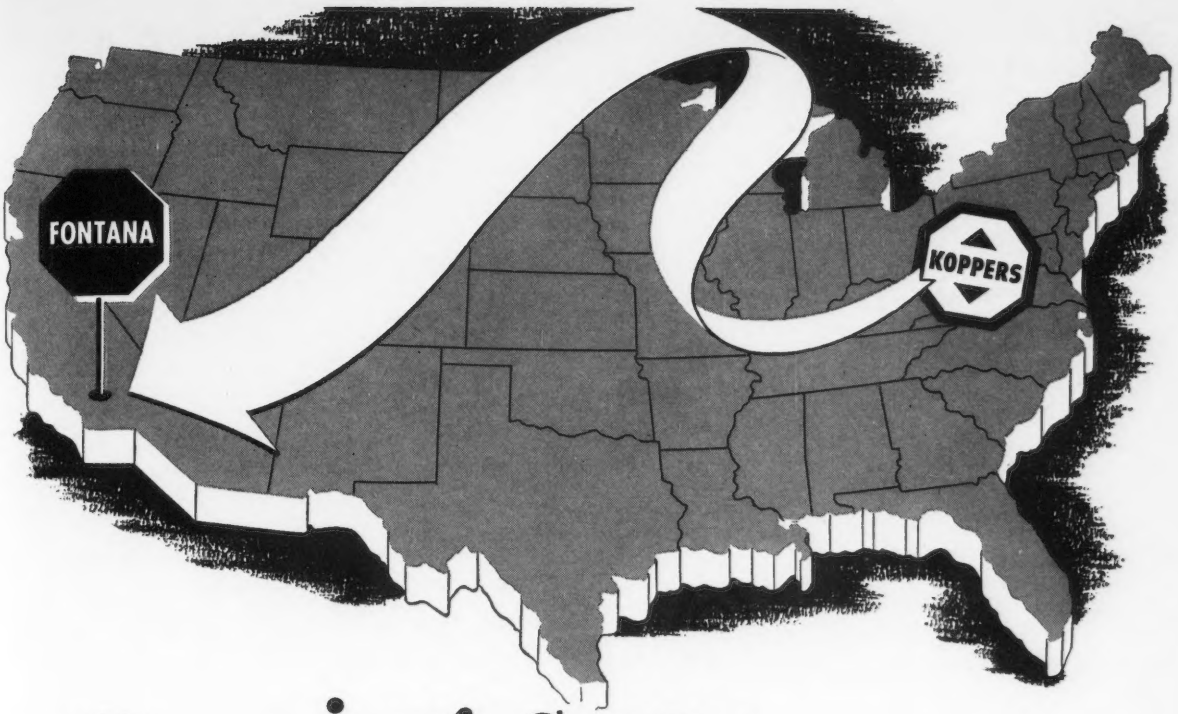

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Bitumastic Enamels are the tough coatings that are used to protect buried oil and gas pipe lines against severe corrosive elements. Large-diameter steel water pipe lines also are protected, both inside and out, by Bitumastic Enamel. On the inside of the pipe, this enamel is applied in a smooth lining that keeps flow capacity high and reduces pumping costs.

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For information on delivery of Bitumastic Enamels . . . on the West Coast or elsewhere in the United States . . . we invite you to get in touch with us.

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KOPPERS COMPANY, INC., Tar Products Division, Dept. 804T, Pittsburgh 19, Pa.

Correlating Committee Report Is Projected

The report of the Correlating Committee on Cathodic Protection, an industry group interested in formalizing procedures pertaining to the intereffects of adjacent cathodic protection systems, is being prepared for publication by the National Association of Corrosion Engineers. The 48-page, 6 x 9-inch booklet consists of Bulletins I through IV issued from time to time since 1948 by the committee. All bulletins previously have been published in Corrosion as well as in other periodicals and many copies have been distributed by cooperating committee members.

It is believed, however, the convenience of having all four bulletins under one cover will be sufficiently advantageous to make the reprinted version popular.

The bulletins incorporated in the reprint are: I—Management Information on Cathodic Protection of Buried Metallic Structures Against Corrosion; II—Cathodic Protection Notification Procedures; III—Cathodic Protection Technical Practices, and IV—Joint Cathodic Protection Systems.

Representatives on the committee are from the American Gas Association, American Petroleum Institute, American Public Works Association, American Water Works Association, Association of American Railroads, Bell System, Edison Electric Institute, International Municipal Signal Association, National Association of Corrosion Engineers, United States Independent Telephone Association, Western Union Telegraph Co.

Testing Article Reprinted

The July article in CORROSION, "A Proposed Standard Method for Measuring the Electrical Resistance of Pipe Line Coatings," by Walter F. Rogers, B. H. Davis, Lyle Sheppard, L. G. Sharpe, E. R. Allen, Donald Bond and P. T. Miller, has been reprinted for sale by NACE. A very limited number of copies of the article is available at 50c a copy postpaid until the supply is exhausted.

Arrangements Made To Bind Copies of Corrosion Magazine

Members of the association who wish to have their copies of Corrosion bound under cloth covers annually either "as is" or with the technical section and indices alone or the technical section, abstract section and indices alone may now do so as a result of arrangements with a Houston bookbinding firm approved by the association's executive committee. The arrangements approved call for the member himself sending to the binder the collected copies he wishes bound. The association will not be a party to the transaction and is involved only to the extent of recommending the binder as reliable and efficient.

Following are details of the arrangement:

1. The name and address of the bookbinder are:

Art Bookbinders, 616 West 19th St., Houston, Texas.

Following are four options respecting the binding in full cloth with sewed pages and the prices for each option. These prices are net to the bookbinder, no discount, mailing and packing costs extra:

1. Binding Technical Section only $3.50
2. Abstract Section only..... 3.50
3. Technical and Abstract Section in one volume..... 3.75
4. All pages bound in one volume 4.00

Delivery time, 30 days.

These prices are offered under the following conditions:

1. Binder will receive all orders and magazines directly from the person wanting the binding.
2. Completed volumes will be shipped directly to the purchaser.
3. Billing and/or payment will be directly to the binder.

The National Association of Corrosion Engineers will not be a party to any transaction and offers this information for the convenience of Corrosion readers and makes no warranty of any nature whatsoever in connection with any transaction. The binder named is known to be reliable and competent.

NACE

New Members and Changes of Address

- **This list is published principally for use by NACE Regional and Sectional officers in keeping their mailing lists up to date.**

(Changes through June 27, 1951)

CALIFORNIA

DITTMAN, WILLIAM E., General Petroleum Corp., Box 2122, Terminal Annex, Los Angeles 54, Cal.

KASPER, GORDON EMIL, Dept. of Water & Power, 410 Ducommen St., Los Angeles, Cal.

LOBANOFF, VAL, United Iron Works, 580 Second St., Oakland 7, Cal.

CONNECTICUT

CUNNINGHAM, GEORGE S., Metallizing Service Co., 29 Alden St., Rear, Hartford, Conn.

DISTRICT OF COLUMBIA

PREISER, HERMAN S., 417 Gallatin St., N. W., Washington, D. C.

GEORGIA

NILL, JULIUS H., Metallizing Engineering Co., Inc., 1734 Candler Bldg., Atlanta, Ga.

ILLINOIS

FOWLER, EDWARD F., Public Service Co., 50 Fox St., Aurora, Ill.

SALLE, WILLIAM H., Commonwealth, Edison Co., 72 W. Adams St., Chicago 90, Ill.

TOBIN, H. H., Public Service Co., 50 Fox St., Aurora, Ill.

LOUISIANA

CHESNEY, ROBERT B., Sunray Oil Corp., Box 188, Benton, La.

WARD, RICHARD R. L., Cit-Con Oil Corp., P. O. Box 1578, Lake Charles, La.

MISSOURI

POTASHNICK, R. B., R. B. Potashnick, Box 205, Cape Girardeau, Mo.

NEW JERSEY

HOOKWAY, WILLIAM C., JR., The Cooper Alloy Foundry Co., Bloy St. & Ramsey Ave., Hillside, N. J.

LONGLEY, JAMES E., Lock Joint Pipe Co., 150 Rutledge Ave., East Orange, N. J.

NEW YORK

CROWLEY, EDWARD J., Alox Corp., 70 Pine St., New York 5, N. Y.

DONNELLON, JOHN B., 472 Gramatan Ave., Mt. Vernon, N. Y.

HILBERT, EDWIN W., New York Telephone Co., 140 West St., New York 7, N. Y.

METZGER, PAUL D., Alox Corp., 3943 Buffalo Ave., Niagara Falls, N. Y.

MITCHELL, FRANK K., New York Central System, 466 Lexington Ave., New York 17, N. Y.

NIBLEY, P. P., Trans-Arabian Pipe Line Co., 505 Park Ave., New York 22, N. Y.

SILKWORTH, GEORGE H., Ebasco Services, Inc., 2 Rector St., New York, N. Y.

NORTH CAROLINA

BROOKE, W. G., American Telephone & Tel. Co., 208 N. Caldwell St., Charlotte, N. C.

OHIO

ANDRES, ROBERT F., Dayton Power & Light Co., 25 N. Main St., Dayton 1, Ohio.

SHOOP, JOHN W., Hydrosol System, Inc., 2394 Canal Rd., Cleveland 13, Ohio.

OKLAHOMA

BAKER, ARTHUR D., Phillips Petroleum Co., Adams Bldg., Room 959, Bartlesville, Okla.

CLOTHIER, A. T., The Carter Oil Co., P. O. Box 801, Tulsa, Okla.

LaFORTUNE, J. A., Warren Petroleum Corp., P. O. Box 1589, Tulsa 1, Okla.

WALTHER, HERBERT H., Dowell Incorporated, Kennedy Bldg., Tulsa, Okla.

PENNSYLVANIA

CHRIST, ROBERT E., Pittsburgh Coke & Chemical Co., Neville Island, Pittsburgh, Pa.

EBERL, JAMES J., Scott Paper Co., Chester, Pa.

(Continued on Page 13)

NACE MEMBERS CHANGING STATUS

Notification to Central Office NACE of changes of membership status, including changes of address should be made *personally* by the member.

NACE is reluctant to make changes in membership records except *when asked to do so by members themselves.*

Please note also:

1. **Active and junior memberships are *non-transferable*, because applications are signed personally by members, therefore**
2. **All persons wishing to become members of NACE must submit and *sign personally* an application containing a concise statement of qualifications and including the names of two NACE members in good standing as references.**

New Members—

(Continued from Page 12)

FREEMAN, WILLIAM R., W. A. Briggs Bitumen Co., 3303 Richmond St., Philadelphia 34, Pa.
LYON, EDWIN, JR., Spang Chalfant Div., National Supply Co., Duss Ave., Ambridge, Pa.
SMITH, CLARENCE W., Philco Corp., Tioga & "C" Sts., Philadelphia, Pa.

TEXAS

ALEXANDER, ROBERT C., JR., 1122 Theresa St., Houston 4, Texas.
ALEXANDER, WILLIAM H., University of Houston, N. E. Hall, Room 227, Houston 4, Texas.
GREENWELL, HOWARD E., The Atlantic Refining Co., P. O. Box 2819, Dallas, Texas.
LeROY, ROYCE H., Box 1710, College Station, Texas.
SULLIVAN, J. H., The Atlantic Refining Co., Producing Div., P. O. Box 2819, Dallas 1, Texas.

UTAH

SUNDBERG, JACK O., Mountain Fuel Supply Co., Coalville, Utah.

VIRGINIA

CROCKETT, C. L., Norfolk & Western Railway Co., Motive Power Dept., Roanoke, Va.

WEST VIRGINIA

ORR, GEORGE F., United Fuel Gas Co., Box 1273, Charleston 1, W. Va.

WISCONSIN

MOMOI, JAMES, Kyle Products Plant, 9th & Marion Aves., South Milwaukee, Wis.
RIHA, ROBERT, Heresite & Chemical Co., 822 S. 14th St., Manitowoc, Wis.
WHITNEY, ROY P., The Institute of Paper Chemistry, 1101 East South River, Appleton, Wis.

FOREIGN

FOGELQUIST, HAROLD T., Aramco Overseas Co., Via Sistina 131, Rome, Italy.
JONES, CHARLES H., Texas Petroleum Co., Apartado Aereo 3622, Bogota, Colombia, S. A.

CHANGES OF ADDRESS

(Old address follows new in parenthesis)

ALABAMA

MORTON, DAVID F., 221 Montgomery Lane, Birmingham 9, Ala. (Amercoat Corp., 2391 Dennis, Jacksonville, Fla.

CALIFORNIA

BARNHILL, I. HARRY, Chief Tech. Sec., Public Housing Administration, 1360 Mission St., San Francisco 3, Cal. (Public Housing Administration, 760 Market St., San Francisco 2, Cal.)

DISTRICT OF COLUMBIA

KEMP, JAMES T., 1422 Thirty-Sixth St., N. W., Washington 7, D. C. (American Brass Co., 111 Sutter St., Room 1028, San Francisco 4, Cal.)
URBANEK, JOSEPH P., Office of the Quartermaster General, Chemicals & Plastics Section, Washington 25, D. C. (QM Res. & Dev. Labs., Phila., QM Depot, 2800 South 20th, Philadelphia 45, Pa.)

ILLINOIS

MILLS, GEORGE A., 733 East Third St., Dixon, Ill. (Central Power & Light Co., Box 2121, Corpus Christi, Texas.)
SIMMONS, JULIUS M., Argonne National Laboratory, P. O. Box 5207, Chicago 80, Ill. (Joslyn Mfg. & Supply Co., 1701 McKinley St., Fort Wayne, Ind.)

IOWA

McBRIEN, JAMES H., Box 324, Ames, Iowa. (Great Lakes Pipe Line Co., Box 386, Independence, Kan.)

MISSISSIPPI

BENDER, RICHARD B., Tennessee Gas Transmission Co., 519 Iowa Ave., Clarksdale, Miss. (Tennessee Gas Transmission Co., 228 Winn St., Mt. Sterling, Ky.)

MISSOURI

ELLWOOD, EDWARD E., Steel Sales Corp., 4565 McRee, St. Louis 10, Mo. (Steel Sales Corp., 4575 McRee, St. Louis 10, Mo.)
HEVERLY, L. F., 5425 Chadwick Rd., Kansas City 3, Mo. (c/o Great Lakes Pipe Line Co., P. O. Drawer 2239, Kansas City 13, Mo.)

NEW JERSEY

KLINGER, JOHN C., Oildom Publishing Co., 1217 Hudson County Blvd., Bayonne, N. J. (Pipe Line News, The Pipeliner, 101 W. Alabama, Houston 6, Texas.)
KLINGER, O. C., Oildom Publishing Co., 1217 Hudson County Blvd., Bayonne, N. J. (101 W. Alabama, Houston, Texas.)

NEW YORK

MILES, JOHN A., Ebasco Services Inc., 2 Rector St., New York 6, N. Y. (The Panama Canal, Box 562, Diablo Heights, Canal Zone.)
ZAJAC, TED S., Shell Oil Co., Exploration Prod. Dept., 50 W. 50th St., New York 20, N. Y. (Shell Oil Co., P. O. Box 2099, Houston 1, Texas.)

OHIO

HOSFORD, HARRY W., Harco Corp., P. O. Box 7026, Cleveland 28, Ohio. (Harco Corp., 2156 E. 4th S., Cleveland 15, Ohio.)
HUSOCK, BERNARD, Harco Corp., P. O. Box 7026, Cleveland 28, Ohio. (Harco Corp., 2156 East 4th St., Cleveland, Ohio.)
SEAL, REED E., 2070 Elmwood Dr., Lakewood, Ohio. (2070 East 61st Place, Cleveland 3, Ohio.)

OKLAHOMA

CARMICHAEL, MILES, Cathodic Servicing Co., 134 Heavy Trafficway, Tulsa, Okla. (Cathodic Servicing Co., 1024 N. Olie, Oklahoma City 6, Okla.)
RISELING, T. M., Cathodic Servicing Co., 134 Heavy Trafficway, Tulsa, Okla. (Cathodic Servicing Co., 1024 N. Olie, Oklahoma City 6, Okla.)

PENNSYLVANIA

ALLEN, LOUIS D., 3923 Dis Mount, Dallas, Texas. (108½ Stiles St., Houston 11, Texas.)
POGACAR, C. F., 416 Olympia Rd., Pittsburgh 11, Pa. (Koppers Co., Inc., Koppers Bldg., Pittsburgh 19, Pa.)

TEXAS

DORR, FRANK I., JR., Trunkline Gas Co., P. O. Box 1642, Houston 1, Texas. (United Gas Corp., P. O. Box 2628, Houston, Texas.)

(Continued on Page 14)

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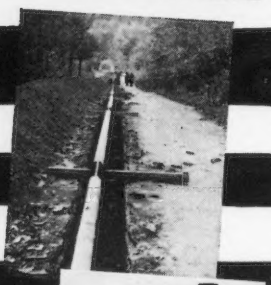

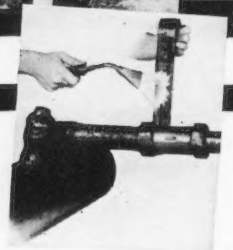

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New Members

(Continued from Page 13)

GRIFFITH, DARREL F., 1704 Lone Tree Rd., Victoria, Texas. (404 W. Goodwin, Apt. 2D, Victoria, Texas.

MONTAGUE, DONALD E., 808 Sul Ross Ave., Houston, Texas. (Michigan-Wisconsin Pipeline Co., 500 Griswold St., Detroit 26, Mich.)

RAIGORODSKY, PAUL M., Petroleum Engineering, Inc., 2480 Times Blvd., Houston 5, Texas. (Petroleum Engineering, Inc., 1421 Commerce Bldg., Houston, Texas.)

SNEDAKER, DELBERT G., 1905 Colquitt, Apt. 3, Houston 6, Texas. (P. O. Box 7119, Houston 8, Texas.)

VOIGHT, RICHARD A., (BILL), Trailer Village No. X-12, University of Houston, Houston 4, Texas. (Trailer Village No. 43, University of Houston, Houston 4, Texas.)

WIMER, CHARLTON J., 527 2nd Unit, Santa Fe Bldg., Dallas, Texas. (2601 Canton St., 7534 Military Parkway, Dallas 17, Texas.)

VIRGINIA

DARIN, EDWARD J., 1210 Radnor Place, Falls Church, Va. (4330 W. Anderson Rd., South Euclid 21, Ohio.)

SHIPMAN, WALDO A., Virginia Gas Transmission Corp., P. O. Box 215, Falls Church, Va. (United Fuel Gas Co., P. O. Box 1273, Charleston, W. Va.)

WISCONSIN

ERNST, JACOB W., Chain Belt Co., 1600 W. Bruce, Milwaukee, Wis. (WERNST, JACOB, Chain Belt Co., 1600 W. Bruce, Milwaukee, Wis.)

FOREIGN

FLORES, LEOPOLDO NETTAL, Ing., Petroleos Mexicanos, Refineria De C. Madero, Tamps., Mexico. (FLORES, LEOPOLDO N., Petroleos Mexicanos, Refineria De C. Madero, Tamps., Mexico.)

JONES, R. M., Liquid Carbonic Venezolana, S. A., Parate Bueno-Antimano, Caracas, Venezuela. (The Liquid Carbonic Corp., 3100 S. Kedzie Ave., Chicago 23, Ill.)

MAGGIACOMO, SAM, Anti-Chem., Ltd., 3583 Dundas St., W., Toronto 9, Canada. (General Flooring Co., 3583 Dundas St., W., Toronto, Canada.)

•

Advance notices of meetings of organizations other than NACE engaged in corrosion work will be published on request in the "Meetings" column.

•

Photographs showing interesting corrosion problems, conditions or solutions of corrosion problems are welcomed for consideration as subjects for the cover illustration of CORROSION magazine. Photographs submitted should be accompanied by an adequate description and the necessary authority to use the photograph.

Notice to Authors of Technical Material in Corrosion

For a handling charge of $5 the National Association of Corrosion Engineers will ship postage paid to authors of technical material published in CORROSION, not earlier than six months after publication, printing plates used for figures in articles, NACE undertakes to ship such printing plates as are available, without warranty as to their condition or completeness. Those who wish to take advantage of this offer are asked to submit a request in writing, giving the issue in which the article in question was published, full address to which plates are to be shipped and billing information to:

NORMAN E. HAMNER,
Managing Editor, CORROSION,
919 Milam Building,
Houston 2, Texas

NEW PRODUCTS – Materials – Service – Literature

American Cyanamid Company has opened a consolidated office and warehouse at 5025 Pattison Ave., St. Louis 10, Mo. Cyanamid, Calco and Lederle products orders should be sent to this address.

•

A Rubber-Based, brushable coating for metal, wood or concrete recommended especially for stair treads, ramps, garage aprons, platforms, marine decks and floor surfaces in general that eliminates slipping even under wet conditions is announced by The Wilbur & Williams Co., Brighton 35, Mass.

•

Welded Polyethylene tank liners are now being made by American Agile Corp., Cleveland, Ohio, Plastics Division, 5806 Hough Ave.

•

A Tandem Type paint heater for production lacquer heating is being produced by Dualheet, Inc., 10118 Detroit, Ave., Cleveland 2, Ohio.

•

Prufcoat Aluminum paint's characteristics are described in Technical Bulletin Sheet No. 025 available from Prufcoat Laboratories, Inc., 50 East 42nd St., New York 17, N. Y.

•

"Preventing Corrosion in Export Packaging," a revised 20-page booklet which explains recommended methods for packaging metal parts for shipment and lists government specification materials and step-by-step methods for their use is available on request from Dearborn Chemical Company, Merchandise Mart Plaza, Chicago 54, Ill.

•

H. M. Harper Co., Morton Grove, Ill., is completing an addition to its plant to house facilities for the reduction of nonferrous and ferrous steel bar stock, complete descaling pickling and coating equipment.

•

Pittsburgh Coke & Chemical Co. has awarded Koppers Engineering and Construction Division a contract to build a new blast furnace at its Pittsburgh Neville Island plant. The furnace will have a capacity of 850 tons of pig iron daily, doubling the output of the plant.

•

Condensed Information on microstructure, critical points, effect of alloy elements, forging, machining, welding and thermal treatment for 14 well known alloy steels used in the production of tubular parts is given in Bulletin TDC 149 available from Babcock & Wilcox Tube Co., Beaver Falls, Pa.

•

Electrunite "Dekoron-Coated" EMT, an electrical wiring raceway consisting of a metal tube covered with a polyethylene extruded coating outside is recommended by the manufacturers for wiring systems exposed to corrosives, salt water, moisture or other unfavorable conditions. Descriptive literature can be secured from Steel and Tubes Division, Republic Steel Corp., 284 East 131st St., Cleveland 8, Ohio.

Dowell Incorporated, a wholly-owned subsidiary of The Dow Chemical Co., has moved into a new office at 1150 North Utica Ave., Tulsa. The magnesium anode and chemical manufacturing plants, warehouse and engineering research laboratories are incorporated in the new building while Kennedy Building offices will continue to house some of the other divisions of the company.

•

Transcontinental Gas Pipe Line Corp. has opened its new office building at 3100 Travis St., Houston, Texas.

•

Koroseal linings for chemical, acid and plating tanks are discussed in a 4-page folder "Corrosion Resistant Lining," available from Metalweld, Inc., 26th and Hunting Park Ave., Philadelphia 29, Pa.

•

"Phoscote Process," Bulletin 9 of the Chicago Bridge and Iron Company, 332 South Michigan Ave., Chicago 4, Ill., contains information on pickling and painting of steel plates, angles, channels and other shapes produced by rolling. The process removes mill scale by immersing steel plates and shapes in sulfuric acid, wash water and phosphoric acid providing a clean, dry surface of iron phosphate.

•

Orlon fiber bag filters developed by du Pont are being used successfully in removing dust, carbon black and other fine-article materials produced in plants manufacturing chemicals.

•

A Soft, Felt-Like paper containing asbestos fibers is being used in air filters developed by The Carrier Corp., which claims they will remove better than 99.98 percent of all dust, smoke, foreign matter, fumes, radioactive particles, spores and microorganisms, including those in the especially critical size of two to three-tenths of a micron in diameter. Static resistance of the filter is less than one inch of water when new.

•

Tuffy Vinyl corrosion resistant finishes are described in a four-page technical data sheet available from Protective Coating Co., 257 Cabot St., Newtonville 60, Mass.

•

Westalite System cathodic protection units supply current for cathodic protection systems at a constant level which, once adjusted, will maintain that value of current irrespective of variation in local soil conditions due to rain, drought or other causes. Adjustments can be made by turning a knob. The units are manufactured by Westinghouse Brake & Signal Co., Ltd., 82 York Way, King's Cross, London, N 1.

•

Amprege E, a thermosetting synthetic resin impregnant for brush or dip coat application to concrete and porous castings has been developed by Atlas Mineral Products Co., Mertztown, Pa. It resists water, salts, organic solvents, many acids and mild alkalies, and resists outstandingly chlorine dioxide and sodium hypochlorite. Bulletin 5-60A gives complete details.

Emulsifier STH, a water-soluble, metal working cooling lubricant is being offered commercially by Product Development Department, General Analine & Film Corp., 22 Center Square, Easton, Pa.

•

Carpenter Steel Co.'s Alloy Tube Division, Union, New Jersey, has issued a "Notebook on Corrosion Resistance," designed to be a guide to the selection of corrosion resistant tubing and pipe. Copies can be obtained on request from the company.

•

Croda Limited, Croda House, Snaith, Goole, Yorkshire, England, has issued a series of technical data sheets on its rust and corrosion preventive products as follows:

Proil—general purpose rust-preventive oil with non-drying finish for inside storage.

Teflan—soft-oil, hot-dipping rust preventive greases. A stiff, waxy grease similar to petroleum jelly.

Buckler—anti-corrosive smearing grease. Wets clean metal surfaces and gives unbroken, smooth film. Will protect metal from daily spraying of one percent salt solution over 180 days at room temperature and at 98 percent humidity.

Penta G. P. 79—a hard film general purpose rust preventive, giving a glassy, almost water white film, non-sticky. A blend of plastic materials in coal tar solvent naphtha and a minute percentage of butyl alcohol. Intended for packed or wrapped articles and not for exterior work.

Bitulan—hard film rust preventive. Quick drying. Steel coated with Bitulan exposed to 100 percent humidity at 40 degrees C. for eight weeks showed only 0.1 percent of surface area corroded. Brass, duralimin and magnesium were completely protected under the same conditions.

Larnol—an oil-type rust preventive. Gives an oily thin film, non-drying.

Prevok No. 3—general purpose rust preventive. A solvent-deposited soft but tough film protects metals exposed directly to weather for periods on order of 50 days provided no unduly wet weather is experienced.

•

Harco Corp., 16993 Broadway, Cleveland, Ohio, has extended its services to include complete engineering, design and installation of cathodic protection devices for underground pipe lines, water storage tanks, lead sheathed cables, flocculators, clarifiers and other metal plant.

•

Rustygon, a non-oil metal primer, reported by the manufacturers to dissolve and prevent rust, coating the metal surface with a plastic-phosphate finish, is available from Gensco Chemical Division, General Steel Warehouse Co., 1830 North Kostner Ave., Chicago 39, Ill. The material dries ready for final painting in one hour but may be left standing several days prior to final painting. Application to wet as well as dry surfaces with equal effectiveness is claimed.

(Continued on page 16)

New Products—

(Continued from page 15)

Permutit Company of New York has developed a new iron exchange unit using new type resins for conditioning boiler water where prevention of scale and reduction of condensate return line corrosion are major problems. The new unit uses plain salt as a regenerant and cannot produce an acid water during the treating step or during regeneration. The use of caustic soda and sulfuric and hydrochloric acids in the regeneration process is eliminated.

•

Fiberglas pipe line rock shield, made of bitumen blended with inorganic filler and reinforced with Fiberglas Coromat is being marketed by Owens-Corning Fiberglas Corp. The material is applied by a two-man crew with pressure-sensitive tape or metal strap. It is made in roll or sheet form. A descriptive brochure is available from the company, at Toledo 1, Ohio.

•

TK-43, a rubbery-type copolymer baked-on plastic coating for the oil and chemical industries, may be applied to metal surfaces in multiple coats to produce thicknesses up to 30 mils. It has high resistance to abrasives and is inert to most corrosive chemicals at normal temperatures. Tube-Kote, Inc., 2520 Holmes Road, Houston, Texas, is manufacturer.

•

Dowell Inc. has reprinted "Internal and External Corrosion Experience in Shell's Products Pipe Lines," by Sydney S. Smith, E. H. Rush and W. J. Curry, Shell Oil Co., an article published in CORROSION, January, 1951.

PERSONALS

M. M. Bowen, 17 years with the Columbian Petroleum Co., at Cucuta, Colombia, visited Central Office NACE July 10. Mr. Bowen, an electrical engineer in charge of corrosion protection on the company's 351 miles of 12-inch line and other installations, reported living cost high because of the state of seige in which the company has been operating since riots last year in the capital. Mr. Bowen is among the early members of NACE and has a file containing every issue of Corrosion since its inception. Columbian Petroleum is a jointly owned subsidiary of Socony-Vacuum and Texas Petroleum Co.

•

George A. Bulmer has been named West Coast branch manager by Insulmastic Corp. of America with headquarters at Los Angeles.

•

L. E. Menns has been appointed Pacific Coast salesmanager for Bridgeport Brass Co.

•

A. E. Buchanan has been appointed sales representative for Federated Metals Division, American Smelting and Refining Co. for North and South Carolina, the eastern half of Georgia, and all but the extreme western part of Florida.

•

Robert D. Huntoon has been named associate director of the National Bureau of Standards in charge of the bureau's newly established Corona Laboratories near Corona, Cal., which will be concerned with electronic research, development and engineering. The NBS Guided Missiles laboratory will be first NBS unit transferred.

•

Yale W. Titterington has been appointed vice-president in charge of sales for Standard Magnesium Corp. of Tulsa, Okla., with headquarters at Tulsa. A member of NACE, Mr. Titterington formerly was with Dowell, Inc.

•

Ted S. Zajac, chairman of the NACE Technical Practices Committee, has been transferred to the Exploration and Production Department of Shell Oil Company in New York. He has been in the company's production department in Houston.

•

John Simons has been added to the staff of the Central Office, NACE. Simons was hired because of the increased activity brought about by the instituting of the Punch Card Abstract Service. Simons has assumed many of C. E. Thorney's duties. He is a journalism graduate of the University of Texas.

•

Dr. Egon Orowan has been appointed George Westinghouse Professor of Mechanical Engineering at the Massachusetts Institute of Technology. He succeeds Prof. William R. Hawthorne who is resigning to accept the post of the Hopkinson and Imperial Chemical Industries Professorship of Applied Thermodynamics at Cambridge University, England. Dr. Orowan is an authority in the general field of the physics of metals.

•

John M. Frank, Ilg Electric Ventilating Co., has been elected president of the National Association of Fan Manufacturers.

•

F. J. McElhatton, formerly president of NACE and who subsequently served as chairman of the Regional Management Committee and of the NACE Awards Committee, has been named to the position of superintendent of transmission compressor stations of Panhandle Pipe Line Co. He has been head of the company's communications and cathodic protection departments and last year took over the duties of assistant superintendent of transmission compressor stations.

•

Bert C. Prisk has joined the corrosion engineering staff of the Hinchman Corp. He formerly was with Brooker Electric Corp.

•

Ira Broyles, 72, father of **Wayne Broyles** of Brance-Krachy Co., Inc., Houston, died at a Houston hospital July 4 and was buried at his home, Lockney, Texas, where he had lived since 1889. Besides his widow he also is survived by another son, Robert, Houston, Texas.

•

William J. Thomas of Babcock and Wilcox Tube Co., has been named to the Tubing Industry Advisory Committee, a function of the Office of Price Stabilization.

H. J. Schulte has been named district manager operating from the new Cleveland, Ohio sales office of Reilly Tar and Chemical Corp.

•

George A. Fitzgerald has been appointed salesmanager of Industrial Tape Corp., a subsidiary of Johnson & Johnson.

•

John M. Hopwood, chairman of the board of the Hagan Corp. and its subsidiaries, died June 8 at Vero Beach, Fla., at the age of 67. Son of a Welsh coal mine operator, he came to the United States in 1904 at the age of 21.

•

C. R. Horton, Jr., has been appointed manager of the Engineering Development Co., Dravo Corp. Engineering Works Division, Pittsburgh. **D. H. Marlin,** a member of NACE, will be his assistant.

•

George V. Luerssen, formerly chief metallurgist of Carpenter Steel Co., Reading, Pa., has been named vice-president in charge of metallurgy. **Dr. Carl B. Post** succeeds Mr. Luerssen. Dr. Post's most recent technical achievement was in connection with cerium alloys of corrosion and heat resistant steel to improve hot workability.

•

Wayne A. Johnson, formerly a field corrosion engineer with Texas Pipe Line Company, Houston, specializing in cathodic protection of pipe lines and tanks has taken a position as senior corrosion engineer with Cathodic Protection Service, Houston, Texas. He is a Texas A. & I. 1947 graduate and an NACE member.

•

C. E. Thorney, who for three years has been on Central Office staff of NACE, resigned effective July 15 to take a position with Hudson Engineering Co., Houston. He will have charge of materials control and purchasing for the firm's cooling tower division. Thorney joined NACE one year after graduation from Northwestern University as a mechanical engineer. His duties with NACE included assigning exhibit space, preparing programs, contracts and management of printing operations at Central Office besides acting as principal assistant to the Executive Secretary and as assistant to the managing editor of CORROSION. He attended NACE Conferences at Cincinnati, St. Louis and New York and was responsible for the collection and fabrication of the NACE exhibit at New York. Mr. Thorney has seen NACE almost double in size and expressed the hope and belief the association will continue to grow and the many friends he has made will prosper.

•

Fontana to Address Three NACE Sections

Mars G. Fontana, of Ohio State University, Columbus, Ohio, NACE Vice-President, is scheduled to make the following addresses to Sections of NACE:

September 17—New Orleans-Baton Rouge Section.

October—Eastern Wisconsin Section.

December—Philadelphia Section.

Corrosion Abstracts

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*** PAGINATION OF CORROSION ABSTRACTS**

Two numbers appear on each page of Corrosion Abstracts. The number in the upper outer corner is for page sequence within the issue only. The number in the lower outer corner, which is followed by the letter "a," denoting "abstracts," is for the convenience of those who bind Corrosion Abstracts by volumes. Because both numbers appear on each page and because it is believed indexing by the volume serial number will be more useful, the "Index to Corrosion Abstracts" is keyed to the number in the lower outer corner of each page followed by the letter "a."

GENERAL

• Fundamentals

1.8, 6.2, 6.3, 5.3

A Contribution to the Study of the Surface Oxidation of Metals at High Temperatures. J. Benard. *Metallurgia Italiana,* **42,** 3-6 (1950) Jan.

Oxidation tests at high temperature carried out on iron and copper have shown that the lattice orientation has a very clear influence: The strain hardened metals—by rolling or stretching—and the next annealed, so as to eliminate the strain hardening but not the preferential orientation, show remarkable variations in the oxidation speed. The same is observed when there is a surface hardening by mechanical polishing. The lattice orientation of the layers of oxide might be determinated from the orientation of the metal at the surface.—MI.

TESTING

• Laboratory Methods and Tests

2.3, 5.4

Weatherometer Exposure of Paints Containing Rutile Titanium Dioxide of Australian Manufacture. K. R. Bussell. *Paint Notes,* **4,** No. 11, 358-361 (1949).

Paints based on anatase and rutile titanium oxide, titanium oxide + white lead, titanium oxide + zinc oxide, and zinc oxide in a raw linseed oil/bodied linseed oil vehicle have been exposed to accelerated weathering tests. Rutile titanium oxide paints chalked mildly, whereas anatase titanium oxide paints chalked severely. The addition of white lead or zinc oxide increased the rate of chalking of rutile titanium oxide but reduced the chalking of anatase titanium oxide. A "non-chalking zinc oxide paint chalked rather more rapidly than a rutile titanium oxide paint. A chalking grade of zinc oxide chalked at the same rate as a white-lead/anatase titanium oxide mixture.—RPI.

CORROSION TYPES & INFLUENCING FACTORS

• Factors Metallurgical

3.7, 3.5

Nitriding the Martensitic Stainless Steel. H. E. Beyer, Am. Bosch Corp. *Steel Proc.,* **36,** 353-357 (1950) July; 403-407, 421, Aug.

Discussion and data are confined to the martensitic stainless steels and their adaptability to surface hardening by nitriding. The steels studied were 12-89 chromium-1.75 nickel, 12.71 chromium-.21 nickel, 12.90 chromium-.15 nickel, 16.57 chromium-1.74 nickel, 17.15 chromium-.25 nickel and 11.75 chromium-.05 nickel stainless steels. Microstructures of the stainless steels after nitriding are given. Pictures of differently heat-treated steels are included. Nitrided martensitic steels are at least equally resistant and usually superior in resistance to some corrosive media as compared to the same steels in the an-

PRIMARY SOURCES OF ABSTRACTS PUBLISHED IN CORROSION

AER—Aeronautical Engineering Review, Institute of Aeronautical Sciences, Inc. 2 East 64th St., New York 21, N. Y.

ALL—The Abstract Bulletin, Aluminum Laboratories, Ltd. P. O. Box 84, Kingston, Onatrio, Canada.

AWWA—Journal, American Water Works Association. Amer. Water Works Assoc., 500 5th Ave., New York 18, N. Y.

BL—Current Technical Literature, Bell Telephone Laboratories, Inc., Murray Hill, N. J.

BLR—Battelle Library Review, Battelle Memorial Institute Library. 505 King Ave., Columbus, Ohio.

BNF—Bulletin; British Non-Ferrous Metals Research Association. 81-91 Euston St., London NW 1, England.

CALCO—Calco Chemical Division, American Cyanamid Corp. Bound Brook, New Jersey.

CE—Chemical Engineering, McGraw Hill Publishing Co. 330 W. 42nd St., New York 18, N. Y.

CEC—Consolidated Edison Co. of New York, Inc. 4 Irving Place, New York 3, New York.

EW—Electrical World, McGraw-Hill Publishing Co. 330 W. 42nd St., New York 18, N. Y.

GPC—General Petroleum Corp. of California. 2525 East 37th St., Los Angeles 11, Calif.

INCO—The International Nickel Co., Inc. 67 Wall Street, New York 5, New York.

IP—Institute of Petroleum. 26 Portland Place, London W#1, England.

MA—Metallurgical Abstracts, Institute of Metals, London, England. 4 Grosvenor Gardens, London SW 1, England.

MI—Metallurgia Italiana. Associazone Italiana di Metallurgia. Via S. Paola, 10, Milano, Italia.

MR—Metals Review, American Society of Metals. 7301 Euclid Ave., Cleveland 3, Ohio.

NALCO—National Aluminate Corp. 6216 West 66th Place, Chicago 38, Illinois.

NBS—National Bureau of Standards. Supt. of Documents, U. S. Gov't Printing Office, Washington 25, D. C.

PDA—Prevention Deterioration Abstracts. National Research Council, 2101 Constitution Ave., Washington 25, D. C.

RA—Refrigeration Abstracts, American Society of Refrigeration Engineers. 40 West 40th St., New York 18, N. Y.

RM—Revue de Metallurgie, Paris, France. 5 Cite Pigalle, Paris (9e), France.

RPI—Review of Current Literature Relating to the Paint, Colour, Varnish and Allied Industries, Research Association of British Paint, Colour & Varnish Manufacturers, London. Waldegrave Rd., Teddington, Middlesex.

TDD—Technical Data Digest, Air Material Command—Technical Service Section, Central Air Documents Office, Wright-Patterson Air Force Base, Dayton, Ohio.

TIME—Transactions of Institute of Marine Engineers. 85 The Minories, London EC 3, England.

UOP—Universal Oil Products. 310 South Michigan Ave., Chicago, Illinois.

ZDA—Zinc Development Association. Lincoln House, Turl Street, Oxford, England.

nealed or hardened and tempered condition. In the nitrided condition the martensitic group shows a degree of resistance to sulfides even superior to some of the higher alloy austenitic stainless steels. Nitrided stainless will excel in resistance to elevated temperatures as compared to the lower alloy types. —INCO.

CORROSIVE ENVIRONMENTS

• Atmosphere

4.2, 6.4, 2.2

Weathering of Some Aluminum Alloys. Aluminum Laboratories Ltd. *Light Metals,* **13,** No. 147, 215-221 (1950) Apr.

Behavior of 2S (commercially pure aluminum), 3S (aluminum-1.2 percent manganese), 50S (aluminum-0.6 magnesium-0.5 silicon) and 51S (aluminum-0.6 magnesium-1 percent silicon) after exposure for many years to rural, industrial and maritime atmospheres.—BNF.

• Chemicals Organic

4.4, 3.6, 7.1

The Air Force Looks at Synthetic Lubricants. B. Rubin and E. M. Glass. Air Material Command. Paper before SAE, Metropolitan Sec., New York City, (1949) Mar. 17. *SAE Quarterly Trans.,* **4,** No. 2, 287-296 (1950) Apr.

Synthetic lubricants are being looked at with favor by the Air Force because of limitations in the performance of petroleum lubricants at extremely high and extremely low temperatures. The types of materials investigated as synthetic lubricants included: dibasic acid ester, polyalkylene glycols, organic silicon compounds, halogenated hydrocarbon and inorganic radical-organic base ester. The synthetic oil is not corrosive to engine parts. However, the oil affords less protection from corroding agents formed in the engine and from moisture corrosion due to high humidity conditions than petroleum oil. As for corrosion difficulties involving brass and steel couples, it is apparent that pitting of the instrument bearings is due not to the diester itself but rather to the corrosion inhibitor in the presence of metal couples; pitting was obtained with petroleum oils in 3-5 days. The problem is more critical with synthetic oils. Corrosion in presence of couples seems to be a function of the polar compounds. Graphs and tables are included.—INCO.

4.4

Attack by Hot Impregnating Oil on Steel and How to Prevent It. G. Schikorr. *Werkstoffe & Korrosion,* **1,** No. 1, 2-3 (1950).

Impregnating oil is able to attack iron and tin-plated steel sheets to a considerable extent. The attack intensifies with rising temperatures to 200 g/m² per day at 200° C. The attack is attributable to the acidic components of the impregnating oil and can be prevented almost completely by the addition of 1 percent calcium oxide. Diagrams, charts.—INCO. (Transl. available from Henry Brutcher, Box 157, Los Angeles, Calif.)

• Soil

4.5, 3.6

Underground Corrosion: Publications of The National Bureau of Standards. L. C. 984.-Nat. Bur. Stds., Wash., D. C., 6 pp. (1950) Apr. 26. (Gratis.)

A list of Bureau of Standards publications on the investigation of corrosion of metals in soils and studies on electrolytic corrosion caused by stray electric currents.

• Water and Steam

4.6, 3.3, 6.2

The Corrosion of Steel in Estaurine Tropical Water. S. A. Main and T. H. Arnold. *J. Iron Steel Inst.,* **165,** 268-278 (1950) July.

Corrosion of various steels in above waters at Freetown, Sierra Leone, was investigated, and the results compared with exposure in ordinary tropical sea water at Takoradi on the Gold Coast. Some operative factors (e.g., mollusks, sulfate-reducing bacteria, etc.) are discussed. Excellent illustrations. 10 ref. —BLR.

4.6, 2.3, 6.3

A Method for Assessing the Relative Corrosion Behavior of Different Sea Waters on Copper-Base Alloys. T. Howard Rogers. *J. Inst. Metals,* **76,** No. 6, 597-611 (1949-50).

Experience accumulated over many years has shown that the corrosive attack of sea waters on copper-base alloys varies considerably because of factors inherent in the sea waters that are not easily revealed by ordinary chemical tests. The corrosive nature of a sea water varies with the season of the year and also with the time during which the sample is stored before use. These variations in the corrosiveness of different samples make it very desirable that some indication should be given of the corrosiveness of the sea waters when comparing corrosion experiments carried out in this medium. In view of this a simple test, known as the Copper Corrosion Index determination (CCI) has been developed to gauge the corrosiveness of any sample of sea water. It consists in immersing a piece of copper sheet of given area in the sample of sea water and estimating the amount of copper dissolved in 22 hours under standard conditions. The author describes in detail the technique of the test, its use for estimating variations in the corrosiveness of sea waters and its value in accounting for lack of reproducibility in sea water corrosion tests on copper-base alloys.—MA.

PREVENTIVE MEASURES

• General

5.1, 2.3, 5.4

Some Aspects of Corrosion and Its Prevention by Organic Coatings. A. G. Sussex. *Paint Notes* (Australia), **4,** No. 11, 348-357 (1949) Nov.

After a general review of methods of preventing corrosion, the author outlines briefly the electrochemical theory of corrosion. He then compares the present state of knowledge concerning inhibitors in aqueous solutions and inhibitive pigments in paints, etc., and the mechanism by which they confer protection, showing that results so far obtained are conflicting. In discussing accelerated corrosion tests, he again shows that opinions on their value are widely divided.—ZDA.

5.1, 1.2

The Corrosion of Iron. M. Ragg. *Paint, Oil & Chem. Rev.,* **113,** No. 19, 12+ (1950) Sept. 14.

Rust destroys 40 percent of the world production of iron and steel yearly. Prompt and effective measures based on the best available methods must be taken in selecting protective media for iron.

• Cathodic Protection

5.2

Cathodic Protection of Buried Structures. *Petro. Eng.,* **21,** No. 9, D 25-26 (1949).

A review of a paper by Denison and Romanoff. [See also *Met. Abs.,* **16,** 801 (1949); *J. Res. NBS.,* **40,** 301, (1948)]. —MA.

5.2

Cathodic Protection Design Considerations. R. H. McLeod. *J. AWWA.,* 41: 411-412 (1949); *Water Pollution Abst.* 22: 271, (1949) Dec.

Application of cathodic protection to metallic structures in contact with water or soil is discussed and the properties, as anodes, of aluminum, steel, carbon, platinum, magnesium and zinc are compared. Protective coatings can be effecticely used with cathodic protection. The

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current density and number of electrodes required vary with the composition of the water.

5.2, 2.3

Laboratory Methods for Determining the Current Density Required for Cathodic Protection. R. B. Mears and J. M. Bialosky. Symposium on Cathodic Protection, Electrochem. Soc. and NACE, 1949, 37-46.

Several methods are described which have been used to establish the minimum current density required to prevent corrosion under laboratory conditions. These include direct methods and methods, mostly electrochemical in nature, which are based on inference or theory. 36 references are appended.—MA.

5.2

Co-Ordination of Cathodic-Protection Installations to Avoid Interference with Adjacent Structures. L. B. Nelson. Symposium on Cathodic Protection, Electrochem. Soc. and NACE, 1949, 66-72.

The conditions which directly affect interference are listed and the various methods of determining whether electrical drainage is necessary are described. Information is given on how to determine the amount of current which should be drained from the unprotected structure.—MA.

5.2, 8.9

Practical Corrosion Control on Gas Transmission Lines. G. R. Olson and H. V. Beezley. *Corrosion,* **5,** No. 8, 249-253 (1949).

The use of magnesium and zinc galvanic anodes is briefly described, as well as other methods of cathodic protection. —MA.

5.2

The Value of Backfill with Carbon and Graphite Anodes. J. P. Oliver and W. W. Palmquist. *Corrosion,* **6,** No. 5, 147-150 (1950) May.

An examination of the proper type of carbonaceous backfill for use with graphite carbon material as anodes for cathodic protection installations.—BNF.

5.2

Relative Merits of Various Cathodic-Protection Current Sources. G. R. Olson and C. W. Evans. Symposium on Cathodic Protection, Electrochem. Soc. and NACE. 1949 93-96.

It is emphasized that the problem of choosing a current source is primarily an economic one, since provided an adequate current is applied to the structure, the protective effect will be the same regardless of the source. The chief characteristics of three types of current source are briefly considered, namely: 1) the use of rectifiers, 2) the use of gas-engine-driven and wind-driven generators, and 3) the use of galvanic anodes. Very promising results have been obtained by combining wind-driven generators with galvanic anodes. The former are connected to conventional ground-beds so that when they are working, the current discharge from the galvanic anodes is limited and their life thereby extended. During periods of no wind, the galvanic anodes take over and maintain protection. The use of galvanic anodes on their own is, in general, confined to soils with a resistivity <3000 ohm/cc in the case of magnesium and aluminum and <1200 ohm/cc in that of zinc. The outstanding characteristic of magnesium anodes is their high effective driving potential. Zinc has higher anode efficiency than either magnesium or aluminum and is therefore preferable in low-resistance soil. The characteristics of aluminum are intermediate between those of the other two metals, its effective driving potential being less than magnesium but higher than zinc. Anode efficiency is almost as high as for zinc. The rate of metal dissolution per ampere-year is lower than for the other two metals.—MA.

5.2

Magnesium Anodes and Common Sense. M. E. Parker. *Petro. Eng.,* **22,** No. 9, D24-26 (1950) Aug.

It is shown that application of cathodic protection making intelligent use of magnesium anodes may sometimes eliminate corrosion.

5.2, 8.9

Experience and Economic Benefits from Cathodic Protection on Gas-Distribution Systems. A. W. Peabody and C. L. Woody. *Corrosion,* **5,** No. 11, 369-376 (1949).

Data are presented which have been collected from two companies serving 236 cities and towns with natural gas by means of about 5200 miles of 3-inch steel main. It is shown that the use of cathodic protection reduced leaks and that a saving of pipe cost is effected by the use of cathodic protection. Both rectifier units and galvanic anode systems are used, the latter employing zinc, magnesium and aluminum. Information is included on the installation and operat-

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ing characteristics of these anodes. Data are also presented on costs.—MA.

5.2, 8.9

Current Required for Cathodic Protection. N. P. Peifer. Symposium on Cathodic Protection, Electrochem. Soc. and NACE, 1949 47-53.

Published work is reviewed. An important conclusion reached is that the cathodic protection of bare pipe lines is not only feasible, but is an economic possibility. It cannot be done to any great advantage by using a single ground bed as anode, but by the use of distributed anodes or a single continuous anode ploughed alongside the pipe protection can be accomplished. Contrary to general opinion, the cost by these methods is low. 12 references are appended.—MA.

5.2

Interference From Forced Drainage. Robert Pope. *Corrosion*, **6**, 201-207 (1950) June.

A method is described for determining the interference which may be expected on a long structure due to forced drainage on a similar parallel structure and is applied to 4-in.-welded-bare-steel pipes. Effects of presence of coatings, changes in soil resistivity, longitudinal conductivity and diameter of structure, distance to anode and separation of structures are considered. Results are tabulated, plotted, and discussed.—BLR.

5.2, 1.4

A Bibliography on Cathodic Protection. F. A. Rohrman. *World Oil*, 131, 179-180, (1950) July 1.

Lists 436 references by year of publication. Each is classified into one of five categories.—BLR.

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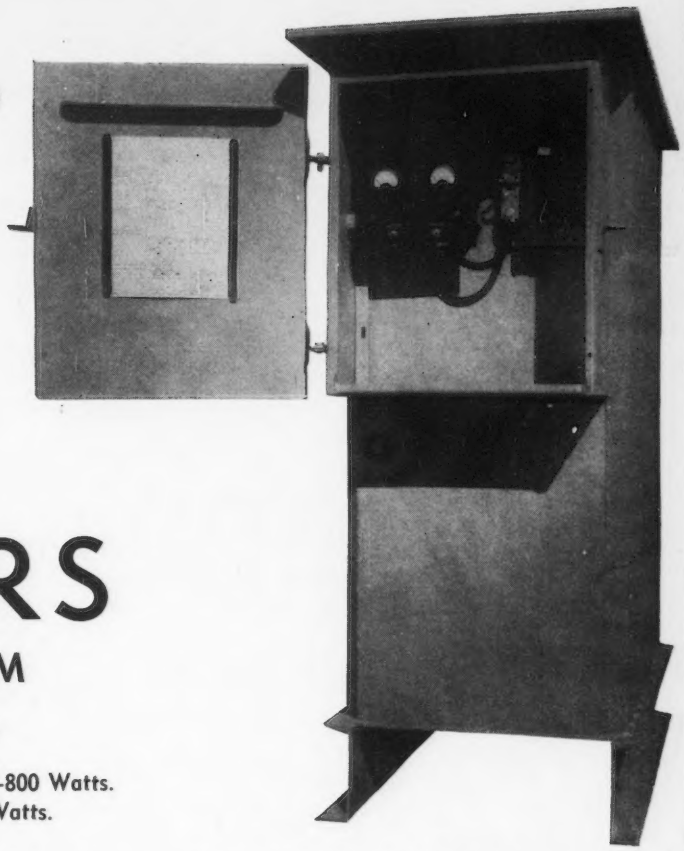

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• Metallic Coatings

5.3, 3.2

Structure and Kinetics of Oxidation of Cathodic Copper. (In Russian). N. A. Merchenko and A. N. Sysoev. *Zhur. Priklad. Khim.* (U.S.S.R.). **23,** 493-495 (1950) May.

Rate of atmospheric oxidation of the above was investigated in relation to conditions of electrolysis and the structure of the deposits obtained. Deposits on electrolytic rolled copper obtained at 5 amp. per sq. dm. are compared to those obtained at 1 amp. per sq. dm. —BLR.

5.3, 5.4

Some Aspects of Corrosion Prevention in Practice. W. Montgomery. *Sheet Metal Ind.,* **27,** 643-653 (1950) July.

Discusses general principles; the "Barffing" process (formation of protective oxide coating on iron and steel by reaction with steam at red heat); vitreous enameling, including various types of defects; testing permeability of enamels; and galvanizing.—BLR.

5.3

Heavy Nickel Plating—For Salvage—For Corrosion Resistance. P. J. Ritzenthaler. *Iron Age,* **165,** No. 14, 98-101, (1950) Apr. 6.

Nickel plating is an excellent salvage method, as nickel is the metal most like the iron or steel used for these parts. It is stronger, more shock resistant, tougher and has a coefficient of expansion very close to that of iron. The advantage over chromium plating is that nickel can be machined by standard shop procedures and regularly-used tools. Nickel can be milled, drilled, bored, reamed, broached, turned and threaded, whereas chromium can only be ground. The nickel layer is firmly bonded and will not chip, crack or peel, and can be considered as cold-welded to the parent metal even in layers as thin as 0.00002 inch. Parts requiring corrosion resistance may be made of cast iron or other low material by applying a heavy coat nickel which can be as thick as 0.080 inch. Photographs.—INCO.

5.3, 7.7

Heat and Corrosion Resistant Wire. *Elec. Mfg.,* **45,** No. 5, 156-158 (1950) May.

Nickel-clad copper wire (Kulgrid) provides good electrical conductivity combined with heat and corrosion resistance. Stranded conductors of this wire can be used as electrical leads in aircraft, electrical furnaces, electrical appliances and jet engines and for equipment where high temperatures or corrosive atmospheres make solid copper conductors brittle and unreliable. Single strands are used for electron tubes. A uniform ratio of nickel to copper is maintained with a series of cold drawing operations, and the nickel cladding ranges from 27%-29%. Mfd. by Sylvania Electric Products Inc.—INCO.

5.3

Metallic Coatings. II. Electrodeposition Processes: Chromium, Nickel, Zinc, Cadmium, Tin, Copper and Brass, and Lead Plating. (In German). W. Wiederholt and H. Arend. Fiat Rev. German Sci. 1939-1946. *Ferrous Metallurgy,* II, 280-293 (1948).

A review. Separate sections deal with: I. General Observations on Plating Procedure. W. Wiederholt, pp. 280-281. 15 references are given. II. Chromium Plating. W. Wiederholt, pp. 281-282. Includes remarks on electrolytes suitable for decorative and hard chromium deposits. 12 references. III. Hard Chromium Plating. H. Arend, pp. 282-286. Deals with electrolyte and anode composition, bath operation, and the hardness of the coatings produced in relation to their uses. 31 references. IV. Nickel Plating. W. Wiederholt, pp. 288-290. Mentions operating conditions for the baths, rapid plating, polished coatings, and the use of boric acid and sodium chloride additions to lessen porosity in the deposits. 9 references. V. Zinc Plating. W. Wiederholt, pp. 288-290. Against inland and industrial atmospheres the corrosion-resistance of zinc coatings is superior to that of cadmium coatings; the latter are more suitable for use in coastal or marine atmospheres. 21 references. VI. Cadmium Plating. W. Wiederholt, p. 290. A brief note. VII. Tin Plating. W. Wiederholt, pp. 290-291. A brief note on the operating conditions and types of coatings obtained with acid and alkaline baths. 2 references. VIII. Copper and Brass Plating. W. Wiederholt, pp. 291-292. Cyanide baths are usually used; at pH-10 brass is deposited, but at pH-12 tombac-type deposits are produced. The anodes are usually made from cast 70:30 brass. 5 references. IX. Lead Plating. W. Wiederholt, pp. 292-293. A brief note on: a) the characteristics of deposits obtained from fluosilicate, fluoboric, perchloric and phenol-sulphonic acid baths, and b) operating conditions of alkaline baths. 1 reference.—MA.

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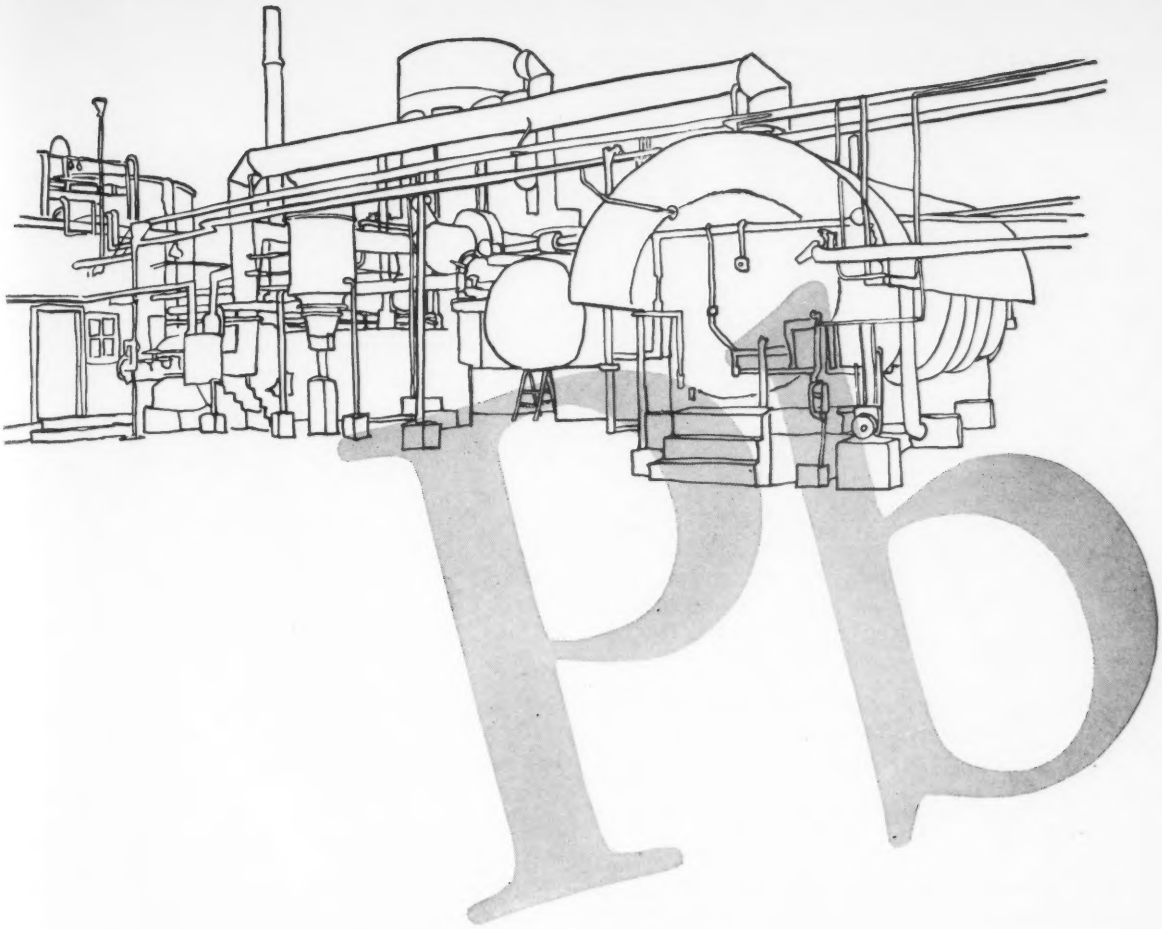

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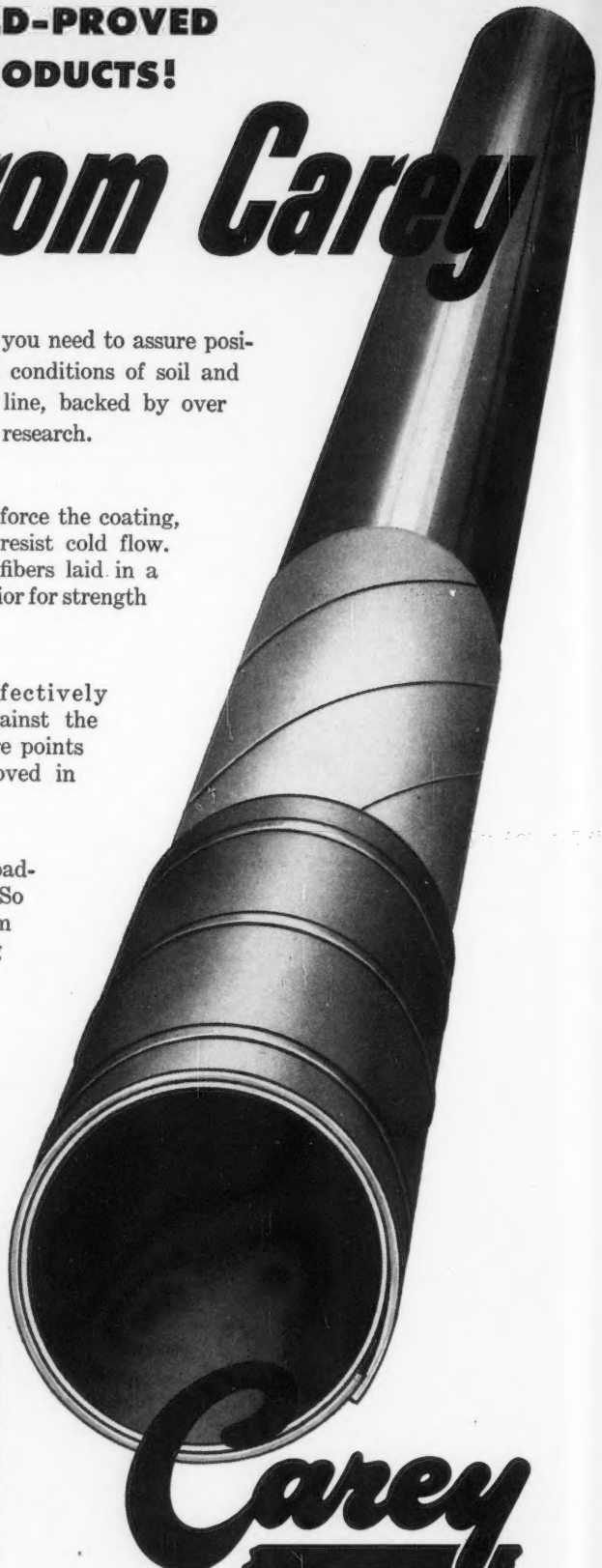

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5.3

Deep-drawing Galvanized Steel Retains Corrosion Resistance After Forming. K. Rose. *Mat. and Meth.*, **31,** No. 2, 63-64 (1950) Feb.

A description of some of the uses to which a deep-drawing grade of galvanized steel has been put. The ductile zinc coating, applied continuously by the Sendzimir process, does not flake when subjected to ball impact tests, and allows the steel to be drawn, corrugated or roll-formed without losing its corrosion resistance. The examples described are a 9-inch deep bowl, 10½ inches in diameter, with a flared rim; a domestic wringer cover; a rectangular refrigerator pan; and a fishing tackle box.—ZDA.

5.3

Choice of Electrodeposited Coatings. C. H. Sample, INCO. Paper before Symposium on Electroplating, Wayne Univ., (1947) Fall. *Plating,* **37,** No. 5, 482-484, May; No. 6, 618, 623-624, (1950) June.

Article calls attention to those factors which should be considered in the selection of electrodeposited coatings. Description of corrosion characteristics and protective value of the coatings includes effect of environmental factors and types of coatings and effects of basis metal. Corrosion behavior is given of typical commercial coatings such as zinc, cadmium, chromium, lead, nickel, tin, copper and gold and other noble metal coatings. 38 references.—INCO.

5.3, 8.4

Nickel-Plated Piping. *Petroleum,* **13,** No. 108, (1950) May.

Use of nickel-plated piping has been found to effectively counteract the corrosive effect of hydrogen sulfide and carbon dioxide on well tubing in the production of sour oil wells.

5.3

Protection of Steel by Metal Spraying. *Civil Eng.,* **44,** No. 520, 578-581 (1949).

Aluminum wire used for spraying is ⅛-inch in diameter, and of 99.5 percent purity, and when all 26 heads of the spraying machine described are in use 1 cwt/hr. of metal is deposited. A high-quality coating 0.004-inch thick can be deposited with a consistency and accuracy unobtainable by hand-operated spray guns, and in addition the cost is considerably reduced.—MA.

5.3, 6.6

Plating on Plastics. *Plating,* **37,** No. 4, 384-387 (1950) Apr.

Electroplating of nonmetallics did not approach the mass-production stage until plastics had found general acceptance and the value of plated plastics had been recognized. After several years of research and pilot-plant studies, methods were developed for bulk plating in barrels of small plastic parts. The plant discussed here has a barrel plating capacity of over a million small parts a day and limited facilities for tank plating of large pieces. The methods employed are flexible. However, there are four basic steps involved in the plating of most plastics: Surface treatment to insure wetting and adhesion of the bond coat (conductive film); application of the bond coat; plating; and finishing. These steps are briefly described, the text being supplemented by a series of plant photographs.—TDD.

5.3

Tin Undercoatings for Paint Are Practical. *Tin and Its Uses,* **1949,** No. 12, 11-12.

Light steel articles such as mudguards can be protected against corrosion by the electrodeposition of a coating of tin. Protection can also be given by the local application of a tinning paste which can be applied by brushing.—RPI.

5.3

Metallic Coatings. VII. Spraying Processes. (In German). W. Wiederholt. Fiat Rev. German Sci., 1939-1946: *Ferrous Metallurgy* **II,** 306-307 (1948).

A brief review, with 9 references. Gas or electrically heated metal-spraying pistols are employed; they are suitable for use with metals in the form of wire or powder. Applications of the method include the production of corrosion-resistant coatings, and the building-up and repair of worn parts.—MA.

5.3

Metallic Coatings, III. Hot-Dipping Processes for Tin, Lead, Zinc, and Aluminum. (In German). W. Wiederholt and R. Haarmann. Fiat, Rev. German Sci., 1939-1946: *Ferrous Metallurgy*—**II,** 293-300 (1948).

A review. Separate sections deal with: I. Hot Tin and Hot Lead Dipping, by W. Wiederholt (p. 293). A brief note, with 3 references. II. Hot-Dip Galvanizing, by R. Haarmann (pp. 294-299). Discusses 1. the principles of the various processes, 2. the influence of bath composition on the course of the reactions, particularly when up to 10 or 12 percent of aluminum or cadmium, respectively, is present, 3. the influence of the silicon and aluminum contents of the steel on the type of coating, 4. the effects of various cleaning and pickling treatments on the quality of the final product. 5. the mechanical and corrosion-resistance properties of the coatings, 6. types of equipment used, and 7. the removal, recovery, and working up of the hard zinc and zinc dross produced during the operation of the kettle. 44 references. III. Hop-Dip Aluminum Coatings, by W. Wiederholt (pp. 299-300). A brief note, with 2 references.—MA.

• Non-Metallic Coatings and Paints

5.4

Paints on Submerged Steel Structures. *Paint, Oil and Chemical Rev.* **113,** 63 (1950) Apr. 13. Translated and condensed from paper by W. Husse, *Farbe & Lack,* **55,** 441-444 (1949).

Outlines investigation of bituminous coatings, use of red lead primers under such coatings, and their properties in comparison with chlorinated rubber and benzyl cellulose coatings.—BLR.

5.4

Capillaries, Capillary Systems, and Capillarity. XXII/5. The Importance of the Donnan Blockage to Corrosion Protection by Polar Coatings and to Substantive Dyeing. (In German.) E. Manegold *Kolloid Zeitschrift,* **116,** 135-136 (1950) Mar.

Shows that, in a capillary system of ionic-polar material, the migration of ions can be obstructed by an electrical blockage. This fact materially reduces the corrosion of metals through protective coatings and hinders the dyeing of textile fibers. Includes schematic diagrams, tables, and graphs. 14 ref.—BLR.

5.4, 4.2

Paints Based on Mineral Oil Distilled from Bituminous Schists. A. Marchionni. *Pitture e Vernici,* **5,** No. 9, 391 (1949).

On pigmentation of the oil, paints, other than white, may be obtained which are weather and acid-resistant and recommended for marine use.—RPI.

5.4

Moisture: Our Common Enemy—But Quality Paints Need Not Peel. J. C. Moore. *Nat. Painters' Mag.,* **17,** No. 4 16-17+ (1950). *NPVL Abs.,* **1950,** No. 158, 117.

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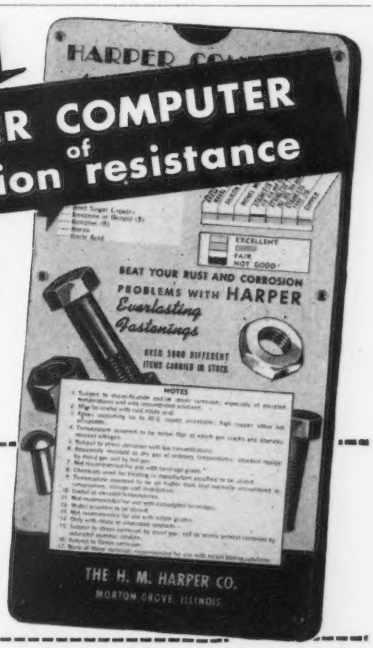

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moisture that becomes trapped under the film. Examples and remedies are given. This paper is a resume of a lantern slide presentation issued by the National Paint, Varnish and Lacquer Association.—RPI.

5.4, 8.9

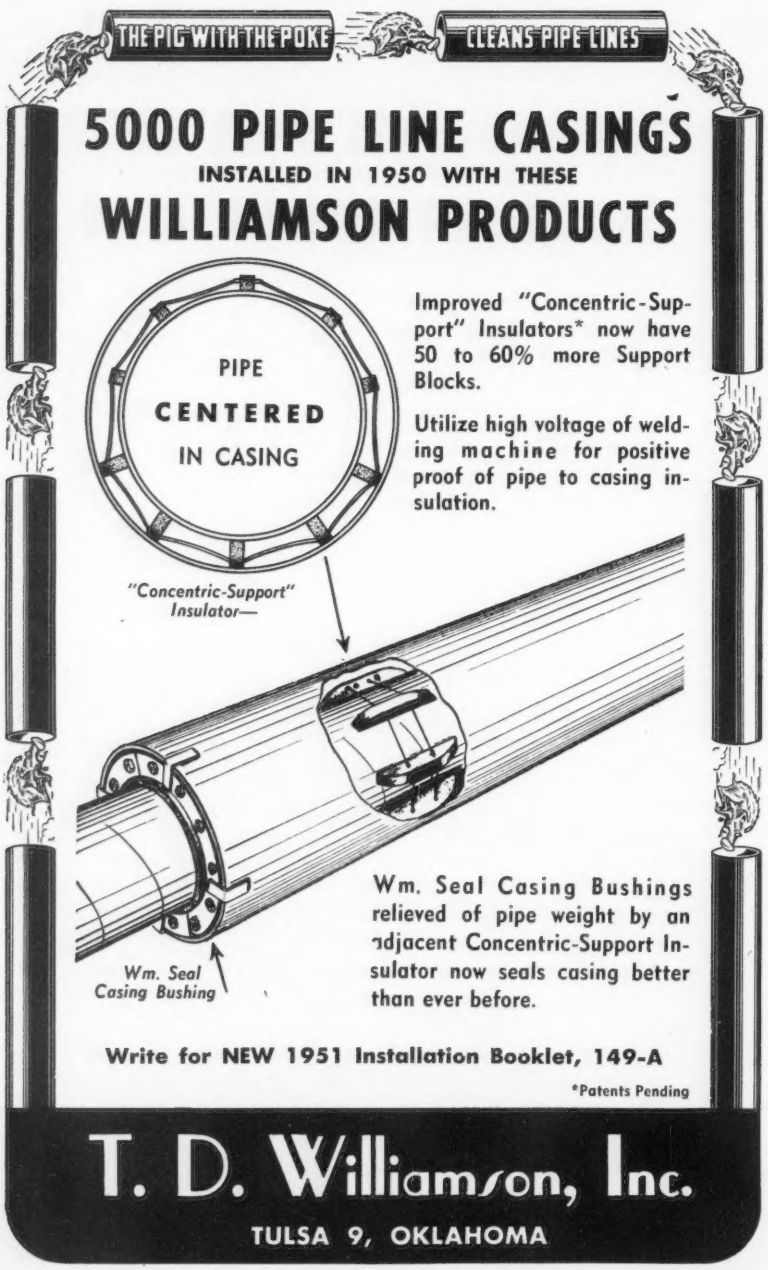
Painting of Motor Car Bodies. *Paint, Oil Colour J.*, **117**, (2686), 994-996 (1950) Apr. 7th.

A report of a paper by G. Murray and W. H. Tomkinson presented to the London Section of the Oil and Colour Chemists Association, and mainly devoted to the application of paint. Where painting was done before assembly, the use of paints highly pigmented with zinc dust gave films with good conductivity which enabled spot welding to be used for joining surfaces, and also protected the steel against corrosion.—ZDA.

5.4

Flame Spraying of Plastics on Metals. J. A. Neumann. Am. Agile Corp., *Ind. & Welding*, **23**, No. 7, 36-39 (1950) July. *Mod. Plastics*, **27**, 85-86+ (1950) June.

An interesting use of flame spraying is that of applying a spray of polythene to a metal object for resistance to corrosion by a large variety of acids, alkalies and other chemicals as well as for electrical insulation. Discussion includes the equipment, surface preparation, preheating, spraying operation, flame structure, technique, testing, adhesion test, ductility, resistance to acid and applications.—INCO.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5.4, 6.4

Northrop Develops New Aluminum Primer. K. B. Niles. *Iron Age*, **165**, No. 5, 90-92 (1950).

A comprehensive series of tests on various aluminum alloys and magnesium showed that a clear synthetic medium-oiled alkyd resin gave more corrosion protection and a better appearance than the conventional zinc chromate.—MA.

5.4, 2.3

Laboratory Tests of Protective Coatings vs. Service Results. W. T. Moran and G. E. Burnett. Bur. of Reclamation Paper before ASTM, 1st Pacific Area Nat. Mtg., San Francisco, (1949) Oct. 10-14; *ASTM Bull.*, **1950**, No. 165, 73-77, Disc. 77-80. Apr.

The ability of laboratory tests to predict service performance of protective coatings is discussed. In some cases, they give a true picture of the serviceability, but in others they provide only part of the answer and the complete picture must wait for results obtained in practice. Some of the Bureau of Reclamation's experiences are given in illustration, with emphasis on protective coatings for metal work. Laboratory testing is endorsed, but there is need for precaution in attempting to draw final conclusions based solely on such testing. The application of coal tar enamels are considered at some length. —INCO.

5.4, 6.4

Painting Aluminum — New Etching Process. Anon. *Transp. World* **106**, No. 3410, 3479 (1949); *Prod. Fin*, **3**, No. 1, 41 (1950); *Railway Eng. Abs.*, **5**, No. 1, 26 (1950).

A process for painting aluminum by means of a primer made up of acid ingredients, resins and corrosion-resisting pigment is described. The composition has the effect of etching metal surfaces, thereby improving adhesion.—RPI.

5.4

New Tank Protection Developed. *Wire and Wire Prod.*, **25**, No. 6, 514 (1950) June.

A new flame-sprayed resin coating called Nukemizing is used on plating, pickling storage and other tanks, and provides a tough, dense and impenetrable membrane that gives complete protection to tank surfaces against acid corrosion. Nukemizing is offered as a complete application service.—INCO.

5.4, 2.3

A New Method of Protection Against Atmospheric Oxidation. (In Spanish.) *E.D.V. Technica Metalurgica*, **5**, No. 43, 331, 332 (1949) Aug./Sept.

A detailed account of the properties and methods of applications of "Zincilate," an inorganic corrosion-resistant paint pigmented with zinc. It is stated that specimens treated with it withstand the ASTM salt-spray test for 1000 hours at 32 degrees C and the weatherometer test for 3600 hours without showing any signs of failure. The steel surface may be cleaned and the paint applied in any of the usual ways. Details are given of heat treatments which should be used to develop fully the protective value of the paint.—ZDA.

5.4

New Corrosion-Resisting Coating Material. *Wire and Wire Prod.*, **25**, No. 5, 440 (1950) May.

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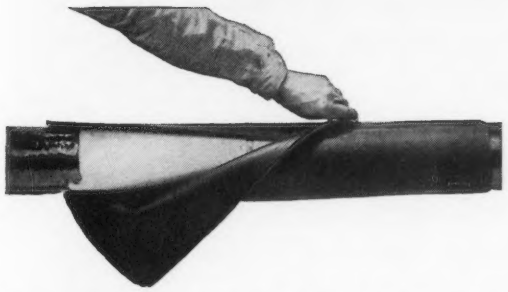

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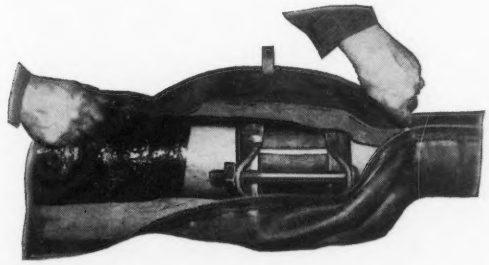

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setting resin, Duron, can be used as an acid and alkali-proof cement or coating.—INCO.

5.4

Significance of Coating Damage in Corrosion-Protection. K. Wurth. *Werkstoffe u. Korrosion,* **1,** No. 1, 20-26 (1950).

The various kinds and the causes of damage of protective coatings of lacquers on metals are discussed. The faults may be due to: 1. the material or its surface preparation being unsuitable for the type of coating applied, 2. errors in the methods of preparing, applying, or drying the lacquer, 3. the subjection of the coating to atmospheric, climatic and mechanical conditions different to those previously expected. When damage occurs, photographs and careful observation of all the above-mentioned factors are essential for the elucidation of its causes.—MA.

5.4

Heat-Resistant Protective Coatings. R. A. Williams, I. H. Lutz and W. H. Hayne. Electrochem. Soc. Annual Convention, 1950; *Electroplating,* **3,** No. 9, 349 (1950).

Three coatings are reported that will withstand temperatures above 800 degrees F for extended periods of time. The coatings have excellent adhesive and corrosion resistant properties. One-coat and two-coat systems are discussed. The primer coat of the two-coat system consists of a pigmented heat-reactive phenolic vehicle. The coating used in the top coat of the two-coat system, and in the single-coat system, consists of pigmented silicone or silicone/alkyd resin combination. The selection of pigments for such coatings is discussed. One coating developed is for use on low-carbon steel. The other coatings are for application to stainless steel. Methods used for formulation, coating and testing are fully discussed.—RPI.

5.4, 2.2, 4.2

Change Occurring in Varnish and Paint Films Exposed Outdoors. H. Rabate. *Trav. Peint.* **4,** No. 8, 362-364 (1949).

The effect of water, heat and cold, solar radiation, dust, atmospheric pollution, wind, atmospheric electricity and terrestial magnetism on paint and varnish films is disussed. Owing to the wide variations in climatic and other weathering influences, several exposure sites are desirable for durability testing. Physical and chemical changes in weathered paint films are discussed and the testing of paint films (e.g., by observing the birefringence of strained films, etc.) is mentioned.—RPI.

5.4

Cementiferous Paints, Part II.—Zinc Phosphate Cements. J. E. O. Mayne. *J. Iron Steel Inst.,* **164,** No. 3, 289-293 (1950) Mar.

The author has developed cementiferous paints based on the reaction between zinc dust and certain phosphate solutions. The paints dry by the formation of a zinc phosphate cement, sufficient metallic zinc remaining to afford cathodic protection to steel. For satisfactory paints, the phosphate solution must be sufficiently strong to ensure adequate cement formation and should have a pH value greater than 8 to prevent premature setting of the paint. Good results were obtained using zinc dust with 30 percent potassium biphosphate and with 35 percent potassium orthophosphate solutions on both pickled and rusty steel specimens. Atmospheric humidity had no effect on the setting of phosphate paints. Although the paints will keep for more than 3 days, it is considered that they should always be freshly made.—ZDA.

5.4, 6.3

How to Prevent Copper Stains. G. B. Perry. *Am. Paint & Oil Dealer,* **43,** No. 7, 40, 67-68 (1950).

Copper gutters, window screens, etc., should be painted with red lead or ferric oxide/linseed oil primer and a finishing paint or, alternatively, where it is desired to keep the copper color, with a spar varnish, to prevent copper stains on adjoining paintwork.—RPI.

5.4

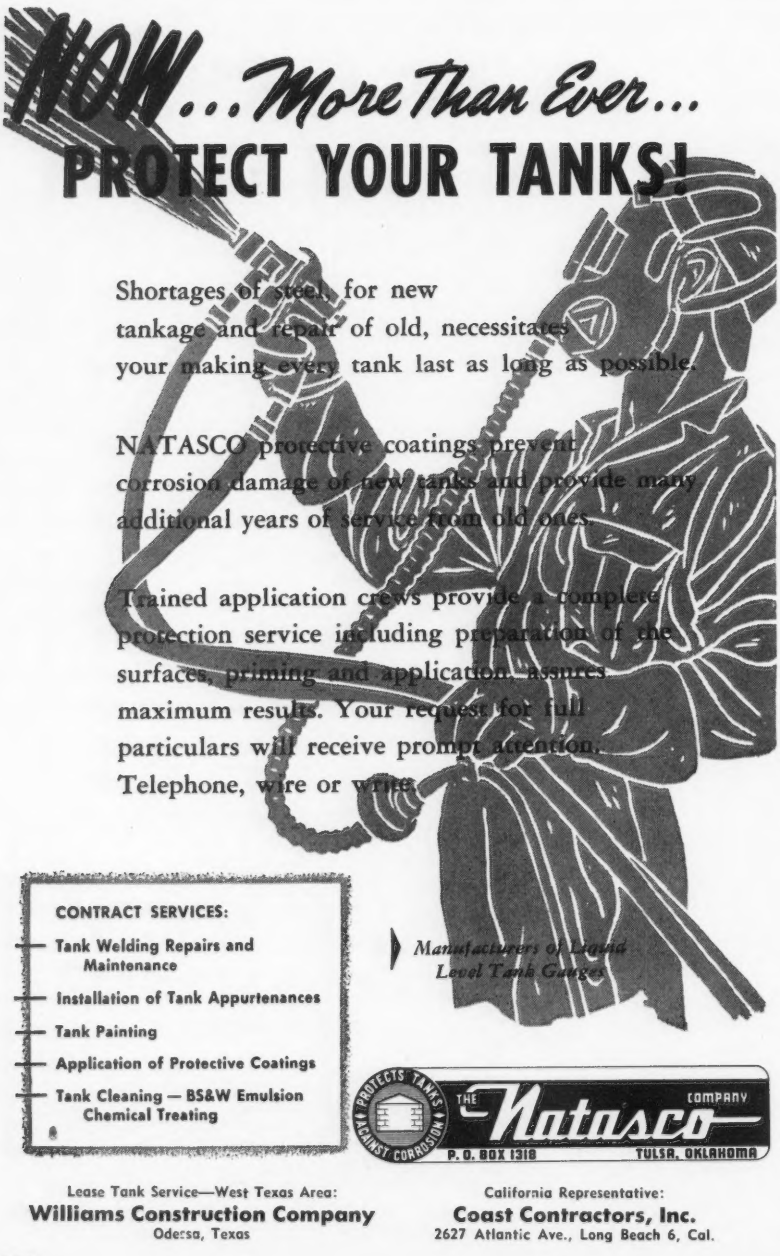
Less Common Metals in the Pigment, Oil, Varnish and Paint Industry. H. Rabate. *Peint. Pig. Vernis,* **25,** No. 12, 439-440 (1949). (Ct. Review, 1948, 1989).

Brief reference is made to the main uses of molybdenum, selenium, tellurium, bismuth, wolfram, zirconium, beryllium, uranium, ruthenium and iridium in pigments (the last three mainly for ceramic use), of thallium and tellurium in anti-fouling toxins, of thorium, uranium, vanadium and lithium in driers, and of ethyl cesium in oil treatment.—RPI.

5.4

Anti-Rust Action of Zinc Chrome. A. Karaus and M. Tabellini. *Pitture e vernici,* **5,** No. 10, 427-428 (1949).

An attempt is made to explain the mechanism of the rust-inhibiting action of zinc chrome on the basis of the fact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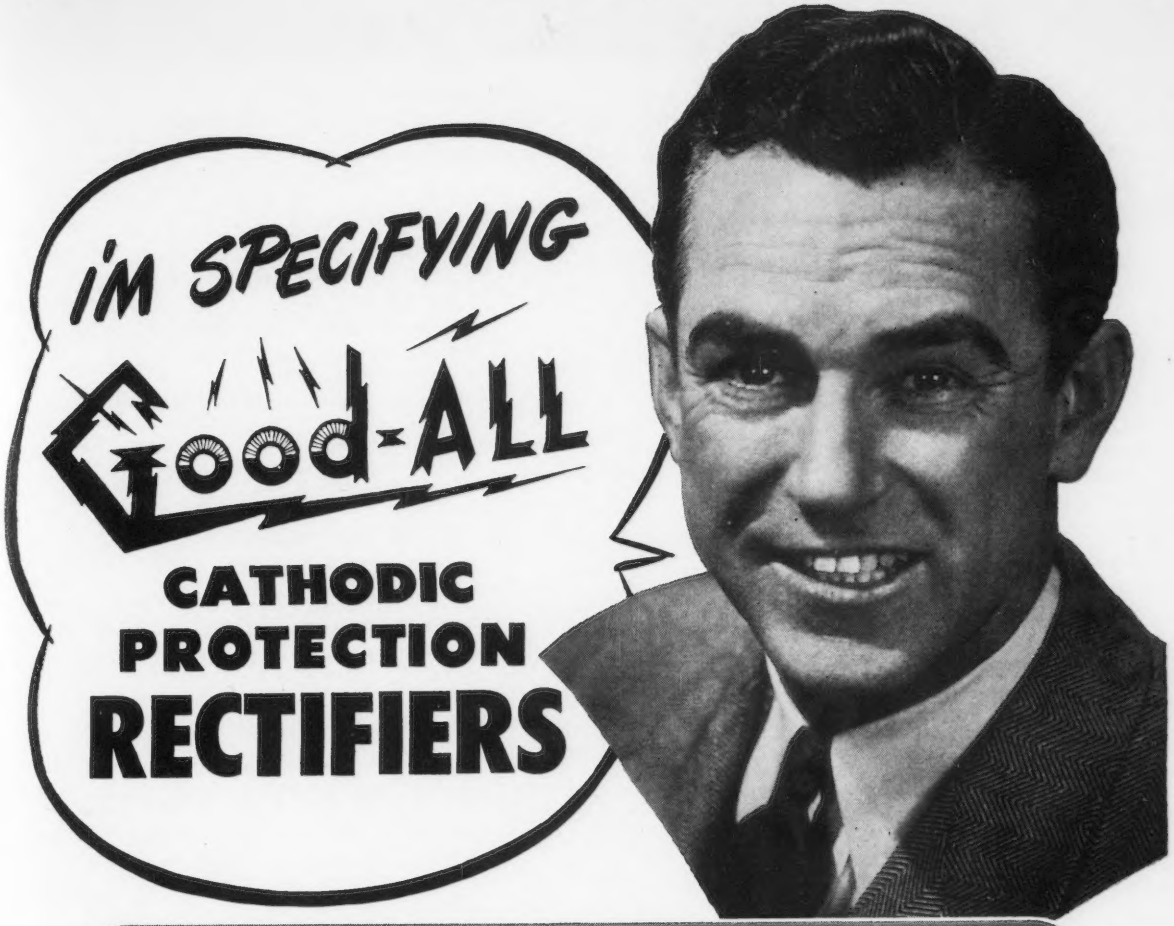

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that it reacts with ferrous salts to precipitated ferric hydroxide.—RPI.

5.4, 1.7

Annual Report, Defense Research Laboratories, Australia, for the year ended 20th June, 1949. Dept. of Supply and Development, Aust., 56 (1949).

A brief summary is included of the work done on paint and allied materials. The use of water spray on exterior exposure of paints has little effect on durability. Tests of safflower oil show it to be of great value as a paint oil. Makita oil (Parinarium laurinum) is valuable as an impregnant for electrical coils. Isobutyl titanate has similar properties to the normal ester.—RPI.

5.4, 6.4

Prime-Coating Aluminum Sheet. *Iron Age; Brit. Ind. Fin.*, **2,** No. 21, 588-591 (1950).

Polyvinyl butyral resin pigmented with zinc chrome and thinned with isopropyl alcohol, butyl alcohol and phosphoric acid gives a wash primer for aluminum which, in addition to its protective properties, provides a key for subsequent finishing coats. The primer is applied before the metal is fabricated and then stoves at 350-400°F, during which process the acid etches the metal.—BNF.

5.4

Reactions of Red Lead. M. A. Ragg. *Paint, Oil Chem. Rev.*, **112,** No. 18, 28+ (1949).

The mechanism of anti-corrosive action is discussed. Among substitutes which are mentioned is Pb_3O_7 (so-called "black red lead") which has similar anti-corrosive properties, subox and grey lead.—RPI.

5.4, 5.9, 8.6, 8.5

Specialty Products Share Industrial Boom. *Chem. Ind.*, **67,** 213-218+ (1950) Aug.

Separate authors survey new developments of past year in agricultural chemicals, protective coatings, rubber chemicals, polishes, textile chemicals, pulp and paper chemicals, industrial adhesives, leather chemicals, disinfectants, household insecticides, and industrial cleaners.

5.4, 6.2

"Scotch" Tape: New Protective Coatings. *Chem. Eng.*, **57,** No. 4, 246+ (1950) Apr.

Polyvinyl chloride film with pressure sensitive adhesive backing is used to wrap the welded steel joints of gas mains. It is sold as Electrical Tape No. 22 and replaces asbestos wrap mopped with hot coal tar. The tape is easier to apply, and cleaner to handle. It is applied in two layers over thoroughly cleaned pipe and protects the pipe from corrosion of the soil, atmosphere, and fumes. Chemical companies cover entire piperuns and the covering is expected to be permanent. Photographs.—INCO.

5.4

Lead Pigments. F. Weber. *Farben, Lacke, Anstrichstoffe*, **3,** No. 10, 329-337 (1949).

The preparation, applications and mode of protection of red lead, white lead and basic lead sulfate are discussed. Barytes is superior to iron oxide as an extender of red lead.—RPI.

5.4

Influence of the Physical-Chemical Properties of Pigments on Anti-Corrosion Paint Films. H. Wagner. *Paint Varnish Production Mgr.*, **29,** 175-184 (1949) July.

A theoretical discussion on the arrangement of red lead, red oxide of iron, zinc chromate, aluminum powder, iron mica and monoclinic lead chromate within paint films, and on the properties which they endow on the films.—ZDA.

5.4, 8.9

Synthetic Resin Paints in Shipping Industry. C. Van Meeuwen. *Plastica*, **2,** 394-399 (1949); *J. Rubber Res. Abs.*, **28,** No. 2, 130 (1950).

A survey is given on the use of these paints in the shipping industry. Requirements include good anti-corrosive properties, flame resistance, and low weight. The most important synthetics for this purpose are the phthalates, the phenolics, polyvinyl chloride resins, chlorinated rubber, and styrenated oils. Attention is given especially to the use of hot and cold synthetic resin paints as anti-fouling agents.—RPI.

5.4

Silicones in the Protective Coating Industry. *Finish*, **7,** No. 2, 30-32+ (1950); *NPVL Abs.*, No. 157,105 (1950).

The usefulness of silicone resins depends on their superior heat and weather resistance. Their solvent resistance is too low to make them useful for places where high solvent resistance is needed. The choice of pigment is important, especially for long shelf life.—RPI.

5.4, 3.5

Porosity of Electrodeposited Metals. VIII. Loss of Weight, Increase of Permeability, and Failure of Electrodeposited Coatings. IX. The Effect of Certain Aromatic Polysulfonates on the Permeability and Corrodibility of Electrodeposited Nickel Foils. N. Thon, Ling Yang and Denis Kelemen. *Plating*, **37,** 749-753 (1950) July.

Present results of experimental investigation of deep and surface corrosion, corrosion through coatings, mechanism of corrosion, etc., of electrodeposited nickel on iron, using various baths and thicknesses. Nickel foils produced in standard Watts baths with and without above addition agents were tested for corrodibility and permeability. All four of the agents resulted in increased corrodibility in an atmosphere saturated with hydrochloric acid vapor. —BLR.

5.4, 3.5

Porosity of Electrodeposited Metals. VII. Rates of Corrosion of Protectively Plated Iron Foils. N. Thon, L. Yang and D. Kelemen. AES Research Project No. 6. *Plating*, **37,** No. 6, 631-632 (1950) June.

By the fine gas-permeability method, it is shown that the permeability of nickel foil increases systematically with the length of the treatment by hot water. Discussion includes the effects of chromium coatings of different thicknesses on the corrodibility of nickel, specifically electrolytic Watts nickel foil of 25 micron thickness, showing no initial permeability.—INCO.

5.4, 3.5

Porosity of Electrodeposits. VI. Effect of Surface Structure of the Base Metal on the Permeability and Corrodibility of Deposits. N. Thon, Ling Yang and Denis Kelemen. *Plating*, **37,** No. 3, 280-281 (1950); *Cf. ibid.*, **36,** 928 (1949).

A report on work carried out under the American Electroplaters' Society Research Project No. 6. Nickel deposits from a purified Watts bath were formed on mechanically buffed stainless steel, mechanically buffed electrolytic copper, electrolytic copper etched with dilute sulfuric acid and electrolytic copper anodically polished in a phosphoric acid solution. Iron deposits were formed on the three different types of copper from a solution containing ferrous chloride 375, calcium chloride 187 g per 1 at 90 degrees C and with a current density of 50 amp. sq. ft. In each case the deposit was stripped from the base metal and its permeability measured. The permeability of the nickel deposits decreased according to whether the base metal was mechanically polished or otherwise, and in the order given above. Of the iron deposits, that on the mechanically polished

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copper was the most porous and the other two had the same porosity. Further experiments on iron deposits from ferrous sulphate baths showed that those formed on mechanically polished copper were more porous than those on etched copper. Similarly, silver deposits formed on dull iron surfaces were more porous than those formed on bright surfaces. In all cases the differences of porosity disappear as the thickness of the deposit increases. In the case of nickel deposits, the differences more or less vanish at a thickness of 8 μ. However, thick deposits formed on mechanically polished layers which in thin deposits show a higher permeability, corrode initially faster than equally thick deposits produced on an etched surface. The remarks refer to atmospheric corrosion.—MA.

5.4, 8.5

Non-Metallic Lining Materials for Process Vessels in the Pulp and Paper Industry. B. Thomas. *Corrosion,* **6,** No. 3, 82-88 (1950) Mar.

Ceramic, carbon and graphite and organic linings.—BNF.

5.4

Improved Protection Against Corrosion. (In German.) P. Tesdorff. *Erdol und Kohle,* **3,** 127-128 (1950) Mar.

Briefly describes the "Sinoxal" process, in which an applied undercoat of a suitable material forms a crystalline, nearly non-porous and electrically passive film on steel surfaces, protecting the latter against many kinds of chemical corrosion.—BLR.

5.4

Four Steps to Better Coatings. K. Tator. *Chem. Eng.,* **57,** No. 3, 223-224 (1950).

In the application to metals of protective organic coatings and linings it is essential that the limitations of the various coatings are understood, that films of adequate thickness are applied, that the serviceability of the coating has been determined and that surfaces are properly prepared.—RPI.

5.4

Corrosion and Protective Coatings. G. E. Speight and D. J. D. Unwin. Annual Reports, Soc. of Chem. Ind., *Progress of Applied Chem.,* **33,** 103-26 (1948). —RPI.

5.4

Plastics Meet the Acid Test. Raymond B. Seymour. *Modern Plastics,* **27,** 91-92+ (1950) Aug.

Presents extensive review of literature on resistance to attack by various chemicals of different types of plastics used as protective coatings, linings, corrosion-resistant cements and other materials. 189 ref.—BLR.

5.4

Characteristics of Mastic-Type Coatings. G. N. Scott. Paper before Pacific Coast Gas Assoc., Transmission Conf., Santa Maria, Cal. *Oil Gas J.,* **49,** No. 12, 283-286 (1950) July 27.

Outline of the use and the description of the results of certain highly informative tests which can be made upon coatings in service. Discussion is confined to application of these tests to a single type of coating. The coatings are performing satisfactorily even under wet and highly corrosive environments. The low conductance of the many coatings tested indicates no marked absorption of moisture by asphalt-mastic coating and the effect, if any, exhibits no bearing on corrosion. The largest proportion of holidays found in the coatings could be avoided by inspection. With proper construction specifications, by using complete inspection programs, and by using suitable methods of testing laid coatings, a perfectly continuous coating may be obtained.—INCO.

5.4, 7.2

Recent Developments in Glass-Lined Pipe. S. C. Orr. *Corrosion,* **6,** No. 4, News Section, 1-2 (1950) Apr.

5.4

Ethyloxylin Resins. *Paint, Oil and Chem. Rev.,* **113,** 45-46 (1950) May 25. Condensed from paper by G. H. Ott. *Bulletin, Association of Swiss Paint & Varnish Chemists,* 3rd Special Issue, 55-63 (1949) Nov.

Describes new and useful class of coating resins, their chemistry, properties and applications. They are obtained by condensation of epihalohydrins with polyhydroxy compounds such as polyphenols.—BLR.

5.4

Protective Coating for Rock-Salt Plates and Metallic Mirrors: Summary and Conclusions. A. H. Pfund. PB. 99151, 7 pp.; *NPVL Abs.,* **1950,** No. 155, 58.

Several successive coatings of the protective materials to be tested were applied to a circular rock-salt plate and the transmission in the infra-red determined. Of the dissolved materials, paraffin and Gilsonite, among others, had high transparency coupled with satisfactory resistance to water vapor. A complex film has been made which is composed of successive layers of the following: 1) a commercial moisture-proofing compound, 2) two or three layers of a paraffin/rubber mixture, and 3) a top coat of Gilsonite. Optically flat surfaces such as prism faces may be protected by means of a coat of a sulfur-selenium mixture. Metallic mirrors may be prevented from condensing water vapor by a thin film of stibnite applied by vacuum distillation.—RPI.

5.4

Vinyl Resins in Industrial Coatings. R. W. Quarles. *Off. Dig.,* **1949** No. 297, 699-710.

Good results have been obtained by the use of a thin coating of a wash primer pigmented with basic zinc chromate or zinc tetroxy chromate followed by a conventional air-drying finish. An anti-corrosive paint is made from a vinyl chloride/acetate resin pigmented with aluminum, red lead, or basic zinc chromate. Other new developments in the use of Vi resins are the introduction of resins compatible with varnishes, N. C. and urea resins.—RPI.

5.4, 5.6

Industrial Research in France and Abroad in the Paint and Varnish Industry. H. Rabate. *Peint. Pig. Vernis,* **25,** No. 10, 371-375; No. 11, 412-416 (1949).

Advances in analytical techniques and physical methods of examination of film-forming materials are briefly reviewed. Results of researches in the anti-corrosion field are discussed, together with certain aspects of the new surface-coated pigments.—RPI.

5.4

Marine Plastic Paints. H. Rabate. *Peint. Pig. Vernis,* **25,** No. 11, 405-406 (1949).

The development of anti-fouling finishes which are applied hot is traced from their first commercial appearance in 1897 to the present plastic finishes formulated and used by the American Navy.—RPI.

5.4

Metallic Nickel Powder Pigment. H. Rabate. *Peint. Pig. Vernis.,* **26,** No. 2, 49-50 (1950).

The manufacture and properties of nickel powder are described, with particular reference to use in the paint industry. Nickel paints have some advantages over aluminum paints, especially in resistance to alkalis. Some formulations are given.—RPI.

5.4, 2.1

Protective Coatings and Their Use in the Building Industry. H. Rabate. *Cahiers Centre Sci. Techn. Batim.,* No. 53, 1-41 (1949); *Peint. Pig. Vernis,* **25,** No. 12, 454 (1949).—RPI.

5.4, 6.4

Finish for Aluminum. *Light Metal Age,* **8,** Nos. 1 & 2, 29 (1950) Feb.

Allied Research Products, Inc., Baltimore, have announced a chromate-type, corrosion resistant finish for aluminum, known as Iridite Alcote. It is applied to parts by a simple, non-electrolytic dip with the solution operating at room temperature. Color ranges from clear to light bronze and may be obtained by an immersion of 10 minutes. For greatest color intensity and optimum corrosion resistance, the immersion time should be set at 2 minutes. Tests on the coating have indicated the following advantages: 1) salt spray tests indicate resistance to corrosion for 1000 hours on wrought stock and 250 hours for casting; 2) excellent paint base characteristics; 3) high resistance to abrasion; 4) the coating aids materially in shielded-arc welding; 5) no special equipment is needed for application; and 6) no special training is necessary for operation personnel.—ALL.

5.4, 1.7

Protection of Enclosed Steel Structural Members. *Ind. Fin. U. K.,* **2,** No. 19, 426-434 (1950) Jan.

Another report on the research into the protection afforded to the inner surfaces of cavity steel walls by a series of 34 paint systems, initiated by the Technical Committee on Protective Coatings of the American Iron and Steel Institute.—ZDA.

5.4

Anti-Corrosive Zinc Chromes. H. Rabate. *Ind. Chim. Belge,* **14,** 42-48+; *Chem. Age,* **62,** No. 1591, 13 (1950).

A discussion of the chemical nature of zinc chromes.

An improved product is obtained by increasing the sodium and chromium contents and carrying out the preparation in acid solution. The crystal form of the product is important, the acicular form giving the best results.—RPI.

5.4, 8.9

Notes on the Protection of Ships' Hulls. H. Masseille. *Chim. Peint.,* **12,** No. 5, 159-163; No. 6, 247-254; No. 10, (1949) 386-391.

A resume is given of various protec-

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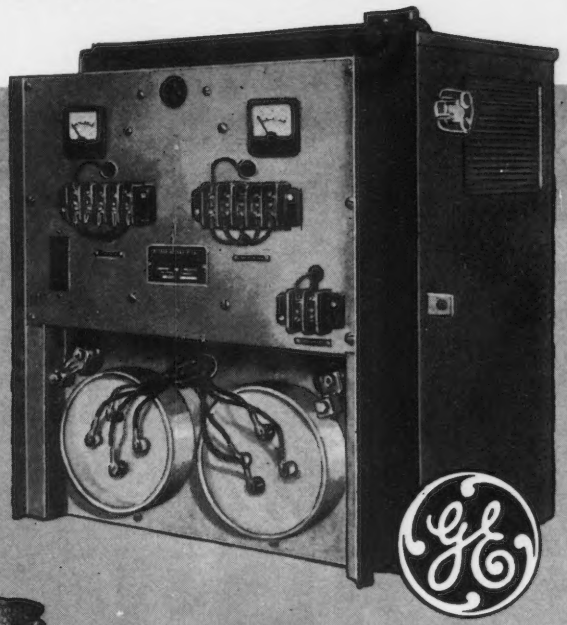

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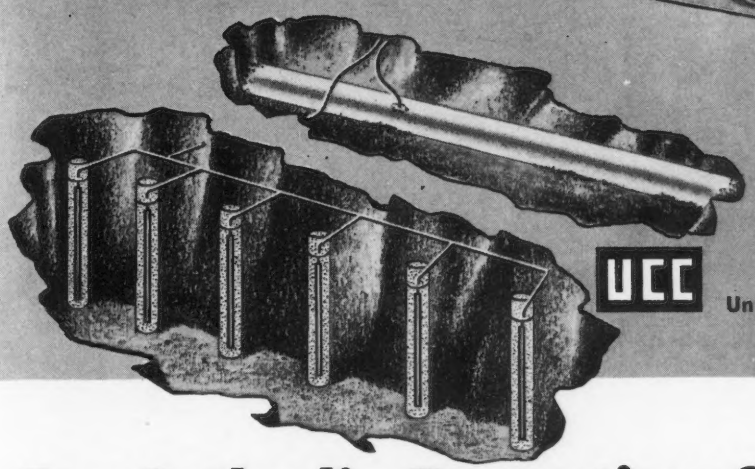

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tive metallic coatings, paints and anti-corrosive pigments. The difficulties of anti-fouling studies are stressed and the possible use of plastic paints as anti-fouling paints are discussed. Formulations of anti-fouling paints, used on French naval ships are given.—RPI.

5.4

Ethyl Silicate Paints. J. Loomans and K. Van Lerberghe. *Chim. Peint.*, **12,** No. 6, 184-190 (1949).

The preparation is described of paints based on a polycondensed ethyl silicate medium (containing approx. 40 percent silica) which is compatible with a wide range of pigments (e.g., lithopone, titanium dioxide, iron oxides, micronized mica, etc.). The pigment/medium ratio varies for each pigment used; if it is too high the paints tend to chalk and if too low they crack. The addition of micronized extenders to, say, titanium dioxide/ethyl silicate paint enables a greater proportion of medium to be used. Anti-corrosive paints may be prepared based on micronized mica and zinc dust. In general, the paints may be applied by spray, have good adhesion to glass, metal and concrete and are resistant to high temperatures. (e.g., 250° for 50 hr. or 450° C for 16 hr.) They are superior to waterglass paints but films are slightly porous.—RPI.

5.4

Slate Powder, S.A.L.C.A. *Ind. della Vernice,* **3,** No. 28, 171-172 (1949).

Formulae are given for anti-corrosive, anti-fouling and bituminous paints containing slate powder as filler. Ultra-fine grades should be avoided as they have very high oil absorptions. Slate is preferable to barytes on account of its lower density.—RPI.

5.4

U. S. Services Report on Plastics. Society of the Plastics Industry of America, Plastics Seminar, Washington. *Brit. Plast.* **22,** No. 250, 141-147 (1950).

Abstracts are given of papers on a variety of applications of plastics. One of them deals with the rain erosion of plastic surfaces for aircraft. Of the many materials subjected to laboratory tests the most resistant were polythene sheet and neoprene rubber. Flame-sprayed polythene is said also to be promising. —RPI.

5.4

Rusty Roofing Iron "Tac Rag." *New Zealand Painter and Decorator's J.*, **3,** No. 6, 8-9 (1950).

An account of the use of zinc metal-pigmented paints in protecting rusty roofing iron against further corrosion. Part of the article is based on ZDA Technical Memorandum No. 6, but it also contains notes on application. The author has confused the powder process for zinc spraying with the use of zinc dust paints.—ZDA.

5.4

Resin Coating for Metal. *Petroleum,* **13,** 19 (1950) Jan.

It is announced in the United States that a method of making tetra-fluoroethylene resin adhere to metals and a process for preparing the finish in a sprayable form have been discovered. The developments are expected to be of considerable interest to the electrical and chemical industries. The material may be used for corrosion-resistant linings for chemical tanks, as an insulating material for wire in electric motors, transformers, and for coating fabrics made of glass fiber. The product is claimed to resist attack by almost every chemical (but not molten alkali-metals) up to 500° F. Its heat resistance is said to permit the production of higher capacity electric motors without any substantial increase in size.—TIME.

5.4

Protective Maintenance Coating that is Rust- and Corrosion-Resistant. *Machinery,* **56,** No. 9, 184-185, (1950) May.

"Kem-Ban" is a rust-inhibitive protective paint, that is also resistant to acids, alkalies, chemical fumes, moisture, salts, and alcohols. The coating can be sprayed or painted and dries in 20-30 min. It will adhere to metal surfaces, including clad metals, and polished and stainless steels and to wood, linoleum, plaster, stucco and cement. Mfd. by Ace Laboratories.—INCO.

5.4

Alkaline Earth Plumbates. N. J. Read. *Paint, Oil Col. J.*, **117,** No. 2682, 716+ (1950).

The preparation, properties and general characteristics of the alkaline-earth plumbates are described. Their rust-inhibiting properties are about equal to those of red lead. A special feature of these pigments is their resistance to blistering when immersed in an aqueous medium.—RPI.

5.4

Plumbates as Paint Pigments. *Paint Man.*, **20,** 128-132; discussion, 132-133+ (1950) Apr.

Describes use of alkaline-earth plumbates as pigments in paints designed to protect steel against corrosion and to reduce lead consumption as compared with other lead pigments. Describes experimental preparation, properties, and exposure-test results. Illustrated.—BLR.

5.4, 8.9

New Painting Method Uses Dry Pigments. *Can. Paint & Var. Mag.*, **23,** No. 12, 39 (1949).

A Swedish ship on the South African run has been partially coated with a powdered flame-sprayed paint in order to compare with normal ship painting techniques. It is claimed that one coat of the flame-sprayed paint will take the place of a red-lead primer and two anti-fouling paint coats.—RPI.

5.4

New Anti-Corrosive Primers. *Marine Eng. & Shipping Rev.*, **55,** No. 5, 116-117, (1950) May.

A series of new anti-corrosive metal primers and surface coatings as well as a new plastic material called Hysol 6000 are used for protecting steel storage tanks, refinery equipment, oil pipes, chemical equipment, and ships and other marine equipment. Hysol 6000 is a new insulating material which is used as insulators in television sets, knife handles, wire coatings, and piping for chemical industries. Mfd. by Houghton Laboratories, Inc.—INCO.

5.4

Metal Primer Adheres to Aluminum. *New Prod. Devel.*, **1950,** April 5.

A metal primer especially for aluminum known as "Di-Noc Metal N33" has been made available by the Di-Noc Co., 1700 London Road, Cleveland Ohio. The primer, which has high abrasion resistance and good adhesion to aluminum without special preparation, may be adapted for application to steel and other metals. A coating of almost any standard finish may be applied over the primer.—ALL.

5.4, 2.3

Discussion of Paper on Electrical Method for Evaluation of Protective Coatings as Moisture Barriers. M. A. Arthur and Others. *ASTM Bull.*, No. 166, 51-3, (1950).

Supplementary information on technique and conclusions are presented.—

8.9, 7.1

Rates of Wear in Railroad Diesel Engines. R. McBrian and L. C. Atchison, Denver & Rio Grande Western Railroad Co. *SAE Journal,* **58,** No. 7, 18-21 (1950) July.

Increasing horsepower reduces main bearing life. Engines that idle excessively wear as much as those always operating at full output. Operating temperatures below 140°F bring high wear rates. High sulfur content in fuel causes corrosive wear. Poor filters do not remove wear-producing dirt and abrasives. Sub-par lube oils will show a high rate of metal pick-up. Improperly mated rings induce excessive ring and ring groove wear. Metal pick-up, directly related to wear, consists of copper, tin, and lead for bearings and thrust washers, silver for wrist pin brushings, and iron for liners and ring wear.—INCO.

5.4

Temporary Protective Coatings: The Use of Latex for Metal Surfaces. *Mech. World,* **128,** No. 3314, 66 (1950).

The temporary protection of metal parts from corrosion and minor mechanical damage, by means of latex coatings produced by dipping or spraying is described. The coatings incorporate suitable corrosion inhibitors.—MA.

5.4

Corrosive Effects of Fungicides. ORR. 185/49 (PB. 4088); *J. Soc. Dyers Col.*, **66,** No. 2, 167 (1950).

Copper naphthenate when used as a fungicide on textiles may accelerate the corrosion of aluminum or zinc with which they are in contact at high humidity, but exerts a protective influence on brass. Zinc naphthenate acts as a corrosion inhibitor to steel, zinc and aluminum. Salicylanilide and dihydroxydichlorodiphenylmethane are inert.—RPI.

5.4, 8.4

Coatings vs. Corrosion. *Paint, Oil Chem. Rev.*, **113,** No. 18, 24-25 (1950), Aug. 31.

Use by Humble of multi-coat protection for their Grand Isle No. 1 off-shore drilling barge in the Gulf of Mexico is described.

5.4, 5.9, 6.4

Alodizing Makes Aluminum Ideal for Chimney Liners. *Mod. Met.* **5,** No. 12, 30-32 (1950).

The use of aluminum liners for domestic and commercial chimneys, to protect the chimney from the corrosive conditions existing, has been made possible by the use of plastic paint coatings. The Alodine process is used to bond the paint to the aluminum. The whole Alodizing and painting process is described in some detail, together with tests which have been applied to the chimney liners.—MA.

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5.4

Anticorrosive Coatings. *Paint, Oil and Chem. Rev.*, **113,** 45 (1950) May 25. Condensed from paper by A. G. Sussex, *Australian Paint Notes*, **4,** 348-357 (1949).

Discusses the above from the corrosion engineer's viewpoint.—BLR.

5.4

When Are Oil-Based Paints Essential? B. F. H. Scheiffele. *Farbe u. Lacke*, **55,** No. 12, 451-452 (1949).

The properties, particularly corrosion-resistance and general weathering quality, of paints based on oil-modified and on non-oily media are considered, and it is concluded that drying oils cannot be dispensed with for brush-applied external paints for metal and wood.—RPI.

5.4

Pre-Finishing of Steel for Plating or Enameling Cuts Production Costs. K. Rose. *Mat. & Meth.*, 67-69, (1949) Oct.; *Prod. Fin.*, **2,** No. 12, 64 (1949).

Sheet steel is buffed and polished ready for plating and coated with a removable protective coating. The pre-finished steel can then be cold-formed in presses and the protective coating removed. No touching-up of the metal is required before plating. The protective coatings may be a lacquer based on vinyl resins, an aqueous dispersion of synthetic resins, or a water-soluble coating.—RPI.

5.4

Physical and Chemical Properties of Quartermaster Fungicide Compounds. A. Rose and A. W. Hutchison. U. S. Quartermaster Corps., Contract No. W44-109-qm-1866, Summary Report, No. 43, 1 (1948); *Prev. Det. Abs.*, **7,** F 38 (1949). —RPI.

5.4

New Marine Primers. K. H. Roll and C. J. Vander Valk. *Marine Eng. & Shipping Rev.*, **44,** No. 3, 51-53 (1949). *Prev. Det. Abs.*, **7,** Lac. 58 (1949).

Details of 11 new primers which are superior to the U. S. Navy and U. S. Maritime Commission Standards are given. They are based on red lead with small additions of zinc chrome, zinc-oxide, iron oxide and magnesium silicate. Paints with media containing a high ratio of resin to oil give best results on total immersion test; for primers above the light load line a higher oil content or an alkyd resin medium is preferable.—RPI.

5.4

Latex Film as Temporary Protective Coatings for Metal Surfaces. *Rubber Age*, N. Y., **67,** 560 (1950) Aug.

Latex temporary coating for ferrous surfaces may cause corrosion unless anti-oxidant inhibitors are incorporated.

5.4

Why Paint Work Blisters. *New Zealand Painter*, **2,** No. 11, 20; **3,** *Chim. Peint.*, **13,** No. 1, 93 (1950).—RPI.

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• Oil and Grease Coatings

5.5, 2.3

Temporary Corrosion Preventives. Symposium before Inst. Petroleum, 26 Portland Place, London, W. 1. Preprint, 82 pp. Mar. 29, 1950. *Fluid Handling*, **1950** No. 5, Apr.

Papers include: The Nature and Scope of Temporary Metal Protectives, M. C. Thompson and D. Clayton; Assessment of the Protective Value of Temporary Metal Protectives, T. G. Clinton; Use of Weatherometer and Humidity Cabinets for Evaluation of Temporary Corrosion Preventatives, G Pohl.

A Method for the Evaluation of Soft-Film Temporary Protectives for Ferrous Articles, T. P. Hoar and G. C. Smith; Application of an Accelerated Atmospheric Corrosion Test to the Assessment of Temporary Protectives, R. St. J. Preston and E. G. Stroud; Tests of the Protective Value of Temporary Protectives on Steel, S. G. Clarke and E. E. Longhurst; Temporary Corrosion Preventives for Aviation Uses and Methods of Testing Them, E. W. J. Mardles and J. Mason; American Methods of Testing Temporary Corrosion Preventives, C. F. McCue and E. R. Blane; Subsidiary Tests for Temporary Corrosion Preventives, H. Hollis.—INCO.

5.5, 3.2

Tarnish Protection for Industrial Silver Plating. E. E. Halls. *Prod. Fin., London* **2,** No. 12, 20-27 (1949).

Immersion of silver-plated material for a few seconds in a 1 percent solution of petroleum jelly in a petroleum hydrocarbon solvent (benzines, white spirit) followed by draining and drying is recommended to prevent tarnishing. The physical and chemical characteristics of a suitable jelly and solvents are given. Tests show the tarnish-resisting properties resulting from the treatment, which does not adversely affect contact resistance and ease of soldering.—MA.

5.5, 6.3, 2.3

S. C. Johnson and Son Develop New Corrosion Inhibitant. *Am. Met. Market*, **57,** No. 128, 1, 3 (1950) July 7.

S. C. Johnson and Son, Inc., Racine, Wisconsin, has developed a dry wax coating which protects aluminum and other metals from rust and corrosion by salt spray, high humidity and other hazards of outdoor exposure. Extensive tests were undertaken which showed that aluminum window frames with the wax coating were undamaged after more than 300 hours in a 20 percent salt spray. Similar untreated aluminum strips were heavily corroded after the same exposure. The wax is easily applied by dip, brush, wipe or spray methods. The dry wax leaves a transparent film on the metal. Handling or contact with packing materials does not remove the wax.—ALL.

5.5, 5.8

On the Anti-Corrosive Action of Soluble Cutting Oils. A. Ferri. *Met. Ital.*, **42,** No. 7, 261-267 (1950).

Having ascertained—on the basis of electrochemical measures—that the soluble cutting oils are anodic inhibitors (and therefore dangerous in as much as they can cause localized attack) the author studies other inhibiting substances in sinergism with oil to the aim of preventing the corrosion which may take place during the machining cycles of the metal. Among the inhibitors studied, the potassium bichromate has proved to be the most suited adding agent for the oil as it is a very good cathodic inhibitor.—MI.

5.5, 5.8

Dipolar Structure and Protective Power of Anti-Rusting Oils. (In Italian.) L. Cavallaro and A. Indelli. Assoc. Ital. Met., 2nd Nat. Congress, May, 1948. Papers on Corrosion, 144-147.

Survey and tests on various polar additives to oils.—BNF.

5.5, 2.2, 2.3

Field and Laboratory Evaluation of Petroleum-Base Rust Preventives. E. L. Walters and R. G. Larsen, Shell Development Co. Paper before NACE, 5th Ann. Conf., Cincinnati, April 11-14, 1949. *Corrosion*, **6,** No. 3, 92-104 (1950) Mar.

The quality of petroleum-base rust preventives can be determined either on the basis of field or laboratory tests. A rough correlation exists between the two types of measurements. Studies of outdoor exposure tests have yielded considerable information concerning composition, application and the influence of environment on protective action. The behavior of petroleum-base rust-preventive films in shed exposure tests is strongly dependent upon atmospheric influences, thus precluding any simple correlation between field and laboratory results. Under controlled field conditions, effects of composition and application on quality are readily ascertainable, but these effects are usually less than noted in laboratory tests. Conventional shed-exposure tests rate petroleum-base rust-preventive films too severely. Charts. 11 references.—INCO.

5.5, 7.1

Oil Can Control Wear. R. E. Jeffrey and J. M. Plantfeber, Shell Oil Co. Paper before NACE, 5th Ann. Conf., Cincinnati, Apr. 11-14, 1949, *Corrosion*, **6,** No. 4, 115-119 (1950) Apr.

A new development in engine lubricants has demonstrated that oil can control wear, where wear is largely due to corrosion. Corrosion of cylinder walls and rings are a factor in engine wear, but only a minor one. The effect of the corrosive action of combustion products is great in the case of high speed Diesel engine applications. Stationary engine operation with a given fuel is more severe than operation of the same engine in a vehicle. Fuels relatively high in sulfur are associated with high wear rates, but it was found that fuels low in sulfur can have equally

high wear rates. Where corrosive wear conditions prevail, Heavy Duty Type oils offer but little aid in wear reduction. A new engine lubricating oil has been developed which reduces wear to as much as one-tenth those of H. D. oils. Tests described confirm this. Photographs. Charts.—INCO.

• Packaging

5.6

Rust-Preventive Methods for Ferrous Metals at Rolling Mills. P. Pieper. *Prod. Fin.*, **2**, No. 9, 24-27+ (1949).

The author discusses the treatment of rolled metal at the mill to prevent corrosion during transport and storage in the open. Solutions of vinyl compounds with the addition of rust inhibitors have been found to be most effective. These should be applied before rusting starts, i.e., while the metal is still hot.—RPI.

5.6, 8.8, 10.4

Corrosion Problems of the Chemical Corps. J. Furrer. Paper before Deterioration Prevention Comm., Corrosion Subcom., Symposium on Corrosion, Nat. Acad. Sci., and ORC, 2901 Research & Develop. Training Group, 1940. *Armed Forces Chem. J.*, **3**, No. 8, 24-26 (1950) Apr.

A review is given of the corrosion research being carried out by the Chemical Corps. Packaging of calcium hypochlorite and semistable chlorinated compounds was enameled-steel drums and glass containers. A better enamel adherence was obtained if the steel had a phosphate coating or was sandblasted before finishing with a phenolic or vinyl-base enamel. The chlorinated compounds are now shipped in wound fiber drums that have an asphalt moisture-resistant outer coating and a zinc oxide lacquered inner lining. For corrosion at high temperatures, stainless steel and Monel are little better than steel. Hastelloy B shows only slight corrosion and Hastelloy C is now being tested. Teflon (polytetrafluoroethylene) and Kel F (trifluorochloroethylene) are used as seals on smoke tanks using FS, a highly corrosive mixture of sulfur trioxide and chlorosulfonic acid.—INCO.

5.6, 6.4

Aluminum Foil as a Packaging Material. W. A. Harrington. *Packaging Rev.*, **70**, No. 43, 42-44+ (1950) Mar.

Discusses pinholes in foil less than 25 microns thick; use of foil for packaging food, dairy products, and tobacco; laminated aluminum foil; corrosion by unsuitable paper laminates; surface polish, etc.—BNF.

5.6

Petroleum Waxes. F. W. and J. W. Padgett. *Chem. Ind.*, (1949) Dec. *Chem. Trade J.*, **126**, No. 3269, 213-4; No. 3271, 350 (1950).

Petroleum waxes are miscible or compatible with many organic materials. Ester gums and the polymerized terpenes usually provide excellent dispersion. Such formulations are used in paper and textile coatings, paints and waterproofing treatments. Refined paraffin wax is used for packaging food products. Other uses are in polishes, rust-preventive dip coating compounds and in textile and leather finishes.—RPI.

• Treatment of Medium

5.7, 5.9, 7.6

Prevention of Black Iron Oxide Deposits Following Chemical Cleaning. P. H. Cardwell, Dowell, Inc. Paper before Midwest Power Conf., Chicago, Apr. 5-7, 1950. *Power*, **94**, No. 7, 98-101+ (1950) July.

Acid cleaning of metal surfaces is an accepted, rapid maintenance tool, but it usually leaves behind an objectionable black iron oxide film. Normal procedures have the disadvantage that all rust formed during the draining steps is metal corroded from the boiler parts. Recommended ways to reduce deposit are the nitrogen displacement and the water displacement techniques.—INCO.

5.7, 6.2, 8.10

Prepared Protective Atmospheres. E. G. de Coriolis, Surface Combustion Corp. *Iron & Steel Eng.*, **27**, No. 4, 76-82 (1950) Apr.

Gases used for protective atmospheres in steel mill furnaces are discussed as to their preparation and their effects on the metal surface. Atmospheres, designed for the prevention of surface deterioration of the steel stock during the anneal process, are also capable of rectifying the detrimental effects of previous processing. This can take the form of correction of decarburization or surface oxidation. Prepared furnace atmospheres should therefore be considered as definite processing agents for improving the quality of steel rather than passive agents for protection of the stock.—INCO.

5.7

Protective Atmospheres in Industry—XIV-XVI. A. G. Hotchkiss and H. H. Webber, Gen. Elec. Co. *Gen. Elec. Rev.*, **53**, No. 3, 36-39; No. 4, 36-41; No. 5, 26-30 (1950) Mar., Apr., May.

Inert gases and highly reducing atmospheres as applied to manufacturing processes in a broad group of diverse industries contribute to equal, or better product quality, with greater safety, and at reduced costs. Discussion of remedial measures that offer prompt solution when applied to protective-atmosphere ailments that are sometimes encountered during operating procedures includes possible sources of impurities and how to locate them. Summary of procedures for correcting conditions that sometimes lead to undesirable effects includes numerous practical suggestions for applying remedies. 44 references.—INCO.

• Inhibitors and Passivators

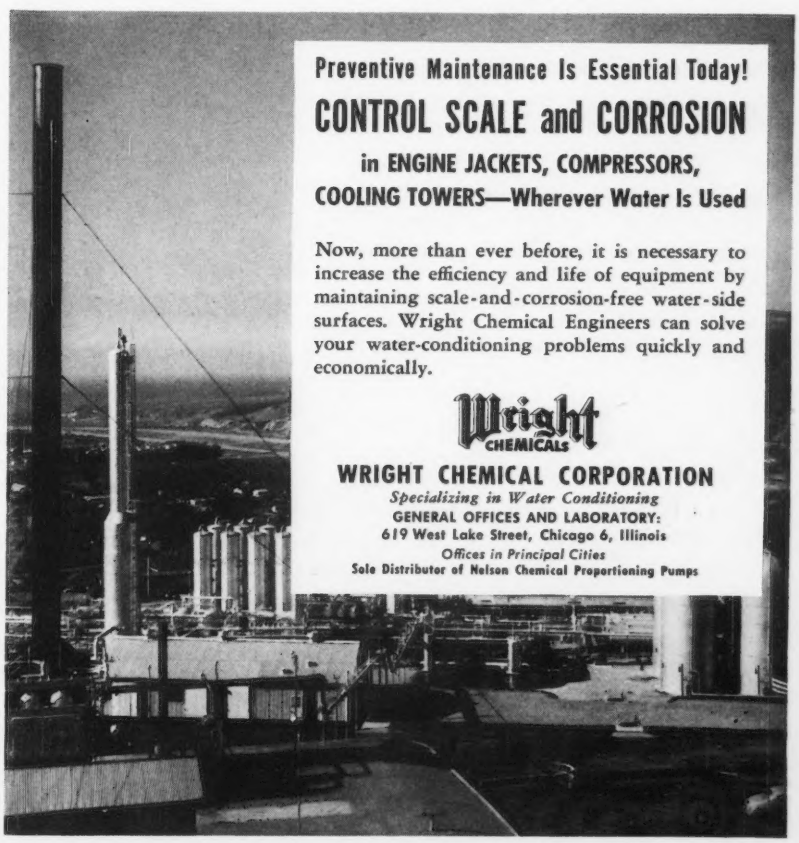
5.8, 8.4

Corrosion Control in the Cotton Valley Field. Alton J. Carroll. *World Oil*, **130**, 141-142+ (1950) May.

Covers main points developed by the Engineering Department, Cotton Valley Operators Committee, relative to the use of organic chemical corrosion inhibitors in preventing internal corrosion of field equipment. Diagrams, graphs, tables, and illustrations.—BLR.

5.8

Evaluation of Rust Inhibitors for Medical Instruments. (In German.) K.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Fishbeck and N. Muller. *Werkstoffe u. Korrosion,* **1,** 52-56 (1950) Feb.

Shows that treatments of steel instruments with sodium carbonate and nitrite solutions are equally effective in reducing the susceptibility to rusting. Photomicrographs and tabulated data are presented.—BLR.

5.8

Corrosion [Effect of Wetting Agents]. M. G. Fontana. *Ind. Eng. Chem.,* **42,** No. 7, 65A-66A (1950) July.

Reports data included in a thesis submitted by H. B. Bomberger of Ohio State University. The corrosion and erosion-corrosion of steel by distilled water of pH 3-9 (adjusted by addition of sulfuric acid or sodium hydroxide) was inhibited by addition of one of the Aerosols (ionic wetting agents) or Sterox-SK (non-ionic). Attack on lead was increased by addition of the Aerosol a non-protective sticky film being produced.—BNF.

5.8, 5.9

A Rust-Preventing Pickling Inhibitor. K. F. Hager and M. Rosenthal. *Corrosion,* **6,** No. 7, 225-231 (1950) July.

The wetting agent Emulphor STH is characteristic of a new class of organic inhibitors which combine excellent inhibiting properties with a stained rust-preventing effect on highly active freshly pickled surfaces. These properties of STH are examined in detail after a brief review of properties of inorganic inhibitors, metallic salts having a relatively high overvoltage, and organic inhibitors which absorb on the cathode area and thus protect metal. The lattice grouping of the molecules of Emulphor STH (the sodium salt of hydrocarbon-sulfamido-acetic acid) cover a very large cross-sectional area of the metal surface. This prevents acid attack on the metal, prevents hydrogen gas generation and provides an extremely adherent uniform film. Inhibitors of this type give excellent protection against sulfuric-acid attack without appreciably altering the rate of attack against the oxide. The chief significance of STH is found in the excellent rust-preventing effect which lasts long after the pickling process has been finished. STH may be easily removed from the metal by means of a dilute alkaline solution.—TDD.

5.8

Inhibitor for Sulfide Corrosion. *Chem. Eng.,* **57,** No. 3, 165-166 (1950) Mar.

A new corrosion inhibitor for sulfide corrosion in producing wells, Corexit, will be marketed by Humble Oil & Refining Co. It is a free-flowing liquid, has no objectionable odor, is non-toxic and low-cost. Composition is not given.

5.8, 4.4

Liquid Form Inhibitor. *Power Eng.,* **54,** No. 6, 44 (1950) June.

Impruvol 20 is a paracresol inhibitor now prepared in liquid form. It increases the life of transformer oils by deterring sludge formation. Mfd. by Koppers Co.—INCO.

5.8, 4.6

Sodium Nitrite as an Inhibitor Against the Attack of Sea Water on Steel. III. Inhibition in Sea-Water/Distilled Water Mixtures. T. P. Hoar. *Chem. & Ind.* No. 27, 546 (1950) July 8.

Mild steel corrosion by sea-water/distilled water mixtures at 25° or 60° C. can be completely inhibited by the presence of a percentage of sodium nitrite greater than 1/5 of the sea-water percentage. It also inhibits the corrosion of white metal and has beneficial influence on copper corrosion by such waters but has no effect on the corrosion of brass at 25° C. Tests indicate that sodium nitrite is an anodic inhibitor.

5.8

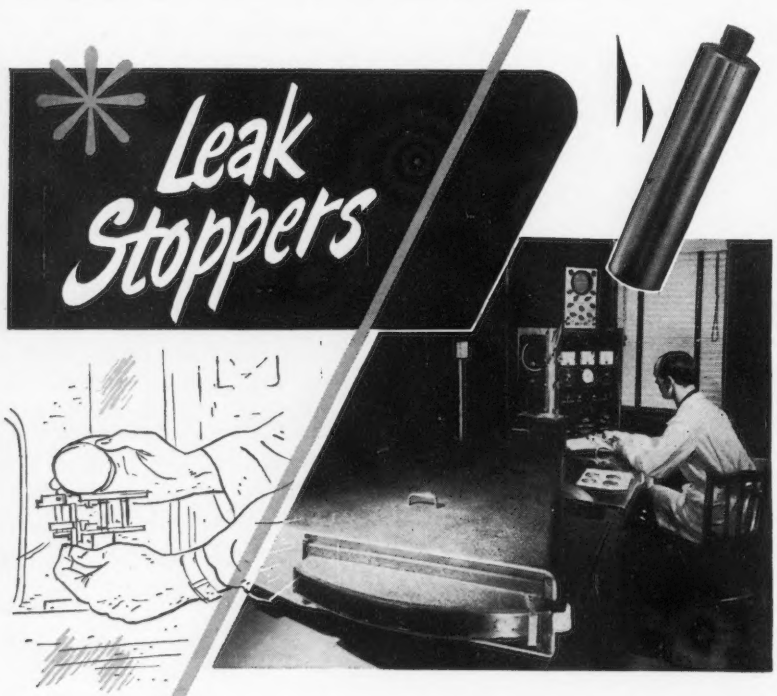
Corrosion—New Rust Preventives. W. D. Robertson. Paper before Inst. for Study of Metals, Chicago, (1950) Feb. 17.

Corrosion of steel and iron by circulating water can be almost completely prevented by small additions of wolfram and molybdenum compounds. The compounds sodium tungstate, potassium tungstate, potassium molybdate and sodium molybdate are useful especially in the air-conditioning and cold-storage industries. They are just as effective as the chromates in curbing corrosion and in lesser amounts. They are expected to be as effective as the chromates in protecting aluminum and magnesium.—INCO.

5.8, 4.6

How Filming Amines Prevent Steam and Return Line Corrosion. J. J. Maguire. *Power Eng.,* **54,** No. 6, 61-69 (1950) June.

A new principle in the prevention of steam and return line corrosion is based on the deposition of a non-wettable film of long chain polar amines on the metal surfaces which acts as a barrier between the metal and the condensate, protecting against both oxygen and carbon dioxide attack. The film remains mono-molecular in thickness with continued treatment



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and will penetrate corrosion products already present to deposit a protective film on the metal. Most useful materials are octadecyl-, hexadecyl- and dioctadecyl-amine. A commercial dispersion of octadecylamine is known as Permacol. Pilot plant data showing the corrosion inhibiting properties of the amines are included.

5.8, 4.6, 5.3

Prevention of Corrosion of Galvanized Iron by Glassy Metaphosphates. F. E. Worsnop and A. Kingsbury. *Chem. Eng., Mining Rev.* (Australia), 173-176 (1950) Feb. 10.

The addition of at least 15 parts per million of a mixture of zinc and calcium metaphosphates was found to protect galvanized iron tanks against the severely corrosive attack of high purity rainwater, without being harmful or distasteful. Zinc metaphosphate is the more effective corrosion inhibitor, but the calcium salt represses waterline attack to a high degree. Slight excess of metaphosphoric acid in the glass is desirable. The inhibitive action only prevents the formation of corrosion products on the galvanized coating and has little effect if these products are already formed. A method of preparation is described.—ZDA.

• Surface Treatment

5.9

Salt Baths Perform Variety of Cleaning Jobs on Most Metals. John B. Campbell. *Mal. & Meth.* **32,** 60-64 (1950) July.

Describes advantages, limitations, applications, and some case histories of non-electrolytic salt baths.—BLR.

5.9

Cut Wire Shot Lowers Cleaning and Peening Costs. D. A. Cargill. *Iron Age,* **165,** 95-97 (1950) Apr. 6.

Above is made from carbon steel comparable to SAE-1065 in analysis. By proper balance of heat treating and cold working, wire with tensile strengths over 250,000 psi, hardnesses of 48-52 Rockwell C, high ductility and long fatigue life is produced. New technique using a high-speed rotary-shear principle cuts multiple wires into accurately sized pieces at reasonable cost. In use, the shot quickly becomes spherical. Users report reductions of as much as 50 per cent in peening costs and 30 per cent to 80 per cent in cleaning operations. Other savings are cited.—BLR.

5.9, 7.6

New Controls for Tube-Film Deposit. *Power,* **94,** 98-101+ (1950) July.

A black iron-oxide film is usually left on internal steel surfaces of boilers and tubing after acid cleaning. Describes experiments on effects of various materials and procedures for use after the normal acid-washing process. Describes nitrogen-displacement and water-displacement methods for reduction of deposit formation. Tables give effects of various solutions on deposit formation and compositions of deposits.—BLR.

5.9, 2.3

The Commercial Electrolytic Polishing of Stainless Steels. P. A. Charlesworth. Paper before Electrodepositors' Tech. Soc., Silver Jubilee Conf., Eastbourne, April 20, 1950. *J. Electrodepositors' Tech. Soc.,* **26,** Adv. Copy No. 2, 11 pp (1950).

The theory is that when a surface undergoes electropolishing by making it the anode in a suitable electrolyte, a diffusion layer is formed which covers the surface, lying more thickly in the hollows than on the high spots. This layer, which results from a local concentration of the products of anodic reaction, has a resistance greater than the main body of the electrolyte and thus protects the hollows and permits the high spots to be preferentially dissolved. The conditions for a commercial process, the solution, the commercial scale working and applications are discussed. Tests carried out utilizing accelerated corrosion testing and weathering tests indicated an advantage for electropolished surfaces. The surface has greater overall reflectivity and clearer color tone. The surface is easily kept chemically and biologically clean. Metal loss is lower than with mechanical polishing. Flaws which might later cause leaks and give rise to pit corrosion are readily shown up.—INCO.

5.9

Soft Grits Provide Low Cost Method for Blast Cleaning Metals. T. F. Clark and E. C. Lathrop. *Mat. & Meth.,* **31,** No. 5, 67-69 (1950) May.

Considerable loss of time and damage to equipment can result from poor cleaning methods with solvents or sand grits in sand blasting. Tests have been conducted towards the development of the use of grits from agricultural residues, such as corncobs, rice and nut shells in conventional blasting equipment for degreasing, removing welding scale, and cleaning metal surfaces prior to plating. All tests were conducted with conventional suction-type sand blasting equipment, provided with compressed air at 90 psi. The results of the tests on soft grits are tabulated, showing penetration of paint films and change in particle size, including dust formed during blast cleaning. Corn cob or hardwood sawdust grits are preferred for degreasing because of their absorbency and efficiency in cleaning electrical equipment without affecting insulation and windings. For general cleaning, grits from nut and fruit pit shells, with or without rice hulls, are satisfactory. Grit-rice hull mixtures will effectively remove welding scale from fabricated steel plate, producing a cleaned surface which is satisfactory for painting. Soft grits may also be used for blast cleaning of metal surfaces prior to plating or galvanizing. Cleaning costs are much lower with the use of soft grits; the grits themselves are inexpensive and need only be used once. Time involved in blasting with soft grits is less, and no drying time is involved as in the use of solvents. The surface finishes obtained by blasting various soft grits against polished aluminum panels are illustrated.—ALL.

5.9, 8.9

Machine for Cleaning Metal Surfaces. Admiralty Corrosion Committee, Hull Corrosion Sub-Committee. ACSIL/ADM/48/427. *J. Brit. Shipbuilding R. A.,* **4,** Abstract No. 2527, 156 (1949) Mar.

An American firm has developed a machine for cleaning metal surfaces by a process which can be regarded as a development of sandblasting. Grit is directed through a "gun," onto the surface to be cleaned, and is then sucked back through the gun, together with the scale or paint removed from the surface, into a reclaiming tank. Here the dust is separated from the grit, and it is then passed into a dust collector. An alternative gun is provided for use at right-angled intersections. The machine consists of three units: The gun, the reclaiming tank, and the dust collector. Although the machine will operate at air pressures as low as 60 lb. per sq. in., the rate of cleaning is considerably lower than at 85 lb. per sq. in. The makers claim that up to 75 feet length of hose between the reclaimer and gun can be used. They also claim that the dust collector unit may be as much as 200 feet from the gun. For work on steel plate surfaces, a hard steel grit is recommended, of which 70 per cent will pass through a 0.028 inch-mesh screen. For efficient operation, the air supply must be dry, the surface must be reasonably

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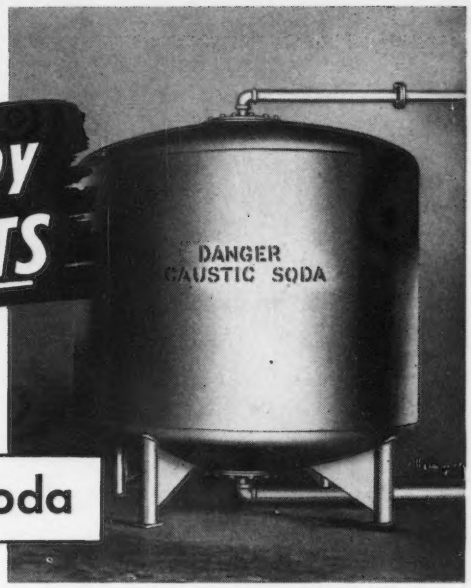

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dry, and it must not be raining. The tool would appear to be of most use on superstructures and other exposed steel surfaces of vessels which are to be laid up for a coniderable period. Although for new shipbuilding and for ships in commission its general adoption would probably not be justified, it would probably lead to economy if it were used in areas of the upper works and the internal structure where access is difficult and sweating is likely.—TIME.

5.9, 5.8, 3.2, 1.3

A Review—Pickling and Pickling Inhibition. A. Douty, Am. Chem. Color Paint Co. *Plating,* **37,** No. 3, 269-271 (1950) Mar.

Review of recent developments in field of oxide and scale removal, with special attention to inhibitors in acid pickling solutions. Of particular interest is the discussion of hydrogen embrittlement and hydrogen blistering as they are affected by inhibitors. Review includes special pickling methods for steels, acid pickling, pickling controls, hydrogen absorption and inhibitors in the plating plant—INCO.

5.9, 5.6

A Survey of the Application and Performance of Temporary Rust Preventives. G. T. Dunkley. *Sheet Metal Ind.,* **27,** No. 279, 599-604+ (1950) Jul.

The cleaning of the work prior to application, the application of rust preventives, types of temporary rust preventive compounds and their uses and wrapping paper and and its uses are discussed. Low sulfate, low chlorine wrapping paper should be used especially with soft-film protectives. Cardboard containers which are dipped in wax should be thoroughly dried before they are wax coated. —INCO.

5.9

Rust Removers. I. G. Farbenindustrie, PB. 65767, Frames 874-7; *Prev. Det. Abs.,* **7,** Met 208 (1950).

Rust on any kind of material, including ironware, can be removed with a warm, aqueous alkaline solution containing certain free amino acids (e.g., those having >1 COOH group per nitrogen atom, e.g., nitrilotriacetic acid) or their sodium salts, a reducing agent (e.g., sodium hydrosulphite) and other optional reagents—RPI.

5.9

Effect of Water-Rinsing on the Subsequent Formation of Phosphate Coatings. L. O. Gilbert. PB 4403, 15 Frames; Board of Trade, Ger. Div., ORR. 429/49.

Water-rinsing of steel surfaces after sand-blasting and prior to phosphatizing lowers corrosion resistance and produces an irregular phosphate coating. Where corrosion resistance is of prime importance there should be no rinsing prior to phosphatizing.—RPI.

5.9, 5.3, 6.5

Preparing Zinc Base Die Castings for Electroplating. J. Haas. *Metal Fin.,* **48,** No. 8, 57-58 (1950) August.

The preparation of zinc-base die castings for electroplating by anodic cleaning is discussed. Tests were made using regular zinc-base die-cast alloys, and articles of zinc cast in gravity fed permanent molds. The latter alloys might contain up to 8 per cent of aluminum. The cleaners employed were in general use in industry. Two different cycles of cleaning are given and the results of each are examined in respect to the amount and classification of blistering as evidenced by the casting after being heated in an oven. It was concluded that the varying results shown by the electrodeposited items were caused by a silicious surface film. The film was formed on the articles by cleaning agents that were in use for several hours. This film was formed on the articles by cleaning agents that were in use for several hours. This film was not soluble in hydrochloric or sulfuric acid, and therefore 1 per cent hydrofluoric acid was substituted for the acid dip. Production runs using the hydrofluoric cleaner and an 11-stage treatment cycle were conducted and then tested by heating. The results were 100 per cent perfect. It is emphasized that the temperature of the electrocleaner in the final preparatory cycle should be kept between the limits specified, since too high a temperature will lead to discolored articles.—TDD.

5.9, 6.2

Salt Bath Cleaning of Gray Iron Castings. B. Robert and H. Herrmann. *Foundry,* **78,** 90-91+ (1950) Aug.

Describes and illustrates continuous process used by Chevrolet-Cleveland Div., General Motors Corp. The castings are normalized and cleaned in a continuous, automatic operation by conveying them through a furnace and a series of baths, including molten caustic, acid, water, and oil.—BLR.

5.9, 5.4

The Engineering Implications and Economics of Surface Preparation of Mild Steel Prior to Fabrication (with Discussion). W. A. Johnson. *Proc. Inst. Mech. Engrs.,* **162,** No. 1, 49-65 (1950).

Methods of surface preparation (for painting), pickling and phosphating, flame cleaning, shot blasting, paint primers and rust-preventive oils, sprayed metal coatings (aluminum and zinc). The last is considered most satisfactory: advantages, economic and practical, are enumerated. Subjects covered in the discussion included atmospheric corrosion in different areas, the comparative costs of the various methods, technique of spraying.—BNF.

5.9

Removing Grease With Lye in Metal Working. (In German.) Richard Justh. *Metalloberflache,* sec. A, **4,** 72-76 (1950) May.

Discusses the chemistry involved in the removal of mineral oils and fats with different types of salts and alkalies. Especially recommends use of trisodium phosphate because it hardly corrodes the metal, yet is very soluble in water. Data are graphed and tabulated.—BR.

5.9, 7.6

Solvent Cleaning and Boiler Design. E. R. Kilsby. *Power Generation,* **1949,** 69, 73, Jan.

Part I. As the author of this article points out, the solvent cleaning of boilers has become increasingly important in recent years. Such methods of cleaning have not only proved extremely effective but their use has influenced boiler design to a high degree. In this part of his article the author discusses the reasons for using solvents as well as the principles involved.—GPC.

5.9

Preparation and Finishing of Metal Surfaces. B. M. Letsky. *Paint Manuf.,* **20,** No. 4, 124-127 (1950) Apr.

The author discusses the removal of mill scale and rust from ferrous surfaces and of grease, etc., from both ferrous and non-ferrous metals. He then mentions possible acid treatments for iron and steel to be used underneath paint, and phosphate processes, principally Parkerizing. Phosphating of zinc surfaces preparatory to painting is recommended to give good adhesion.—ZDA.

5.9, 7.4

Cleaning Tubular Heat Exchangers. P. F. Dougherty and C. H. Brooks. *Trans. ASME,* **71,** 839-841 (1949) Oct. Condensed in *Chem Eng.,* **56,** No. 4, 260+ (1949) Apr.

A discussion of the various methods of cleaning tubular heat exchangers used in industrial processing, particularly in the oil industry. Preliminary examination and laboratory analysis should be used to determine the best method of removal. The use of *in place* circulation of chemical reagents or solvents (especially emulsifying oil) is preferable to mechanical means. Sandblasting is recommended as a last resort. Circulation of inhibited acid solutions was found most advantageous in the water side of heat exchange coolers.—RA.

5.9

Descaling Metals with Sodium Hydride. *Metalloberflache,* B, **1,** No. 7, 53-54 (1949).

The process, developed by E. I. du Pont de Nemours and Co., for descaling by immersion of the parts in molten sodium at 370° C., containing 1.5-2 per cent sodium hydride (obtained by passing hydrogen into the bath) is described. The method is suitable for chromium, cobalt, nickel and their alloys, noble metals and steels; it is unsuitable for aluminum, cadmium, magnesium, lead, tin and zinc as they are either attacked by the bath or melt at the operating temperature.—MA.

5.9

Chromizing. *Prod. Fin.* (London), **3,** No. 1, 78-81 (1950).

The advantages and industrial applications of the chromizing treatment for steel surfaces are surveyed. No details of this high-temperature process are given, but it is claimed that the steel surface is transformed to a depth of several thousandths of an inch into an alloy containing 30 per cent chromium, which confers very high corrosion-, wear-, and heat-resisting properties.—MA.

5.9

Electrolytic Descaling of Tanks. *Pacific Marine Rev.,* **47,** No. 4, 36-37 (1950) April. *Eng. Digest,* **11,** No. 6, 228 (1950) June.

Electrolytic descaling of petrol and oil tanks consists of supplying power from welding machines to an arrangement of anodes suspended in the tanks to be cleaned. Mild steel anodes are used and sea water is the electrolyte. Clean surfaces are found parallel to the anode axis and in the vicinity of the anodes only. Increasing the length and adding extra fins at the bottom of the anodes leads to a complete cleaning. An important feature is the fact that the use of mild steel, rather than insoluble carbon steel, produces practically no hydrogen or chlorine. A special problem of chemical deposits as calcium, magnesium and sodium salts necessitates special cleaning.—INCO.

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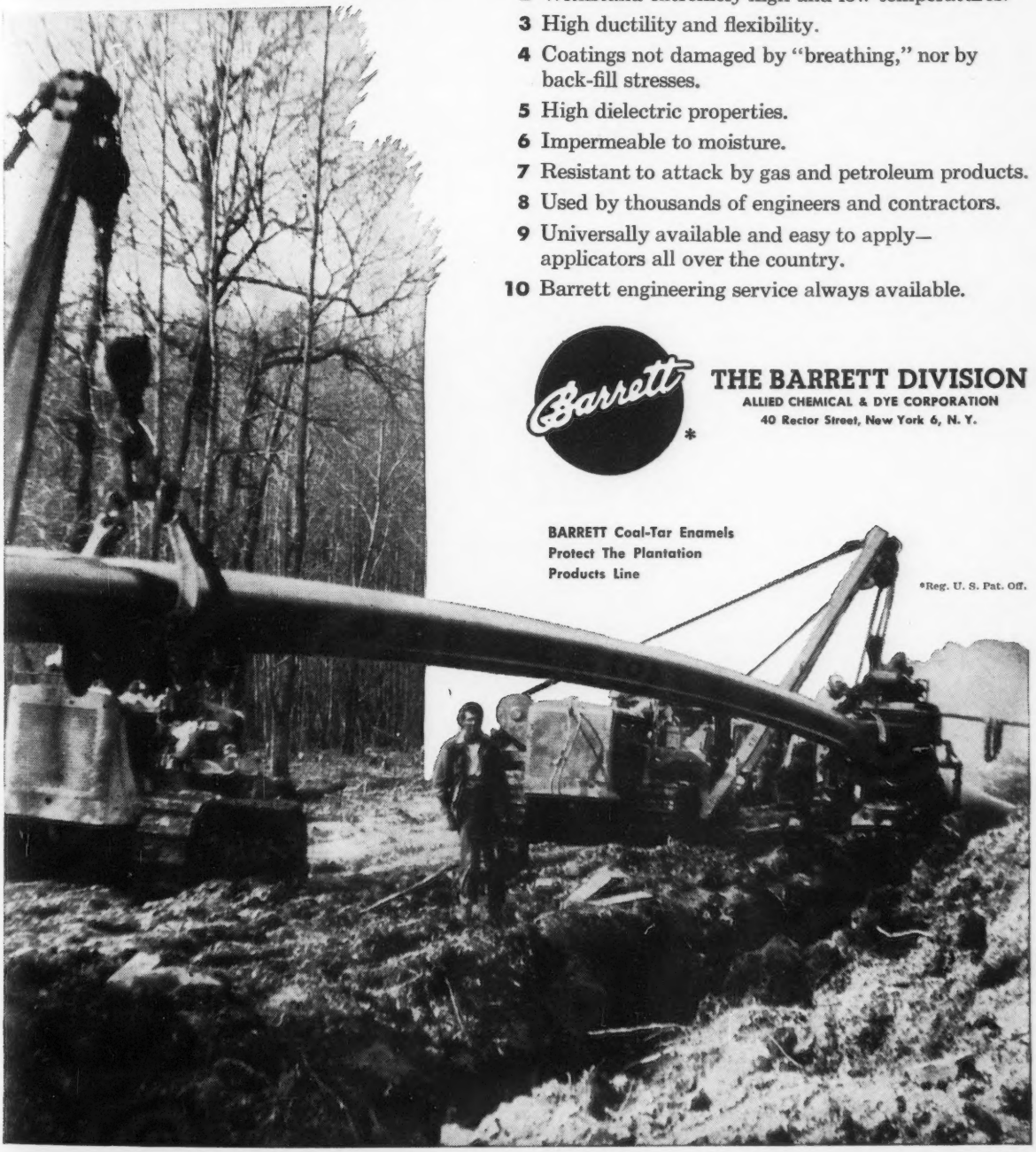

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5.9, 6.4

Anodizing in Color. *Prod. Fin.*, **14,** No. 7, 108 (1950) Apr.

The Technical Processes Division of Colonial Alloys Company, Philadelphia, has developed the Mirrordip Electrodizing Process to color aluminum buttons, buckles, fasteners and ornaments which are resistant to both dry-cleaning and laundering. Dull matte, diffuse or reflective specular surface effects can be produced in many colors, including blue, green, red, in solids and pastels, and brown, wine and black. The colors are not plated on but are absorbed and fixed into the electrolytically treated aluminum surfaces so that they become a part of the metal. Peeling, chipping, or lifting cannot occur. The finishes are resistant to handling, atmosphere, food stains, alcohol and many chemicals including acids and alkalies. No lacquers are required.—ALL.

5.9, 5.4

Methods of Rust Removal and Corrosion-Protection. B. F. R. Scheifele, *Arch. Metallkunde*, **3,** No. 7, 260-161 (1949).

A brief review of: 1) mechanical, chemical and electrochemical methods of cleaning corroded metal surfaces and 2) paint and lacquer films for and chemical and electrochemical methods of corrosion-protection.—MA.

5.9

Important Developments in Metal Finishing During 1949. Walter A. Raymond. *Met. Fin.*, **48** No. 1, 46-55 (1950).

All the various aspects of metal finishing are reviewed. The pronounced drift away from the traditional hand operations of grinding, polishing, buffing and coloring is an important development, these preliminary and after-plating surfacing operations being avoidable, wholly or in part, by the use of chemical and electropolishing, bright plating, periodic reversed-current plating, etc. In addition, there is a wide adoption of semi- and fully-automatic polishing. 171 references are appended.—MA.

5.9, 6.4

Process Finishing Magnesium. S. H. Phillips. *Light Metal Age*, **7,** Nos. 1 & 2, 14-15+ (1949).

The different reactivities of magnesium and aluminum towards cleaning solutions are outlined. A 5-20 per cent chromic acid solution (in distilled water) up to 95° C. is recommended for the removal of corrosion products formed on magnesium during storage and a 15-20 per cent solution for the removal of graphite residues from drawing operations. Simple chemical treatments and the Turco-Waterman process (anodizing in hot saturated sodium carbonate solution) for improving the corrosion-resistance of magnesium and acting as a base for paint are also discussed.—MA.

5.9

Gas-Pickling of Steel. J. Pearson, W. Bullough, and T. C. Canning. *J. Iron Steel Inst.*, **165,** Pt. 2, 185-190 (1950) June.

The treatment of steel strip in atmospheres containing gaseous hydrochloric acid is practiced in the USA for preparing the material for subsequent hot-galvanizing. Laboratory investigations confirmed that galvanized coatings adhere more tightly to steel prepared in this way than to steel pickled in aqueous sulfuric acid. The attack on steel by gaseous hydrochloric acid differs from that by aqueous acids. The process is, however, suitable only for steel which can be heated to temperatures of about 750° C without loss of required properties. Steel which must be finished in a cold-worked condition or with special heat-treatment cannot therefore be submitted to gas-pickling. Neither is the process suitable for the removal of thick scale; the rapid attack of the gaseous hydrochloric acid on any bare steel revealed by non-uniform removal of scale, leads to heavy metal losses and marked unevenness of surface.—INCO.

5.9, 6.4

The Mechanism of Electrolytic Oxidation and the Formation of Coatings of Aluminum Oxide. (In French.) J. Patrie. *Rev Aluminium*, **26,** No. 161, 397-403 (1949) Dec.; **27,** No. 162, 3-7 (1950) Jan.

Study of the effect of different factors on the properties of the anodized layer has led to a theory of the process of formation and development of the film. Production and methods of testing porous films suitable for decoration, thick corrosion-resistant films, hard abrasion-resistant films and flexible films for electrical insulation of wires.—BNF.

5.9, 6.4

The Anodic Oxidation of Aluminum and Its Alloys. Jos. Patrie. *Bull. Soc. Franc. Elec.* vi, **10,** No. 101, 84-94 (1950).

The development, applications and advantages of anodizing are briefly outlined and the theories of the process are critically reviewed. Patrie then describes theoretical work on the subject in which the influence of a number of different factors was examined. Among the cases discussed are 1) the formation during oxidation of a compact insulating oxide layer, and 2) the more usual formation of a slightly porous layer. The influence of different factors during oxidation on the porosity is examined. The decoration of the anodized layer, its protection against subsequent corrosion, methods of testing the service behavior of the material, the anodizing of wires, foil and strip and tests of the brittleness of the film are the subjects of discussion.—MA.

5.9, 3.2

Anodizing: Electrolytes—Film Formation—Electropolishing. D. H. Napier and J. V. Westwood. *Met. Ind.*, **76,** No. 7, 123-126 (1950).

The anodizing of aluminum is carried out for the production of rectifying films, protective and decorative films, and for electropolishing, on three types of solution: 1) those having little or no solvent action on the film, 2) those having appreciable solvent action, and 3) those whose solvent action equals the rate of formation of the film. Napier and Westwood describe the action of those three types of solvent and discuss the theories of film formation. They consider that too much anodic processing is done on empirical lines and that a more scientific approach is needed. A bibliography of 22 references is appended.—MA.

5.9, 3.7

Salt Baths for Annealing and Descaling. E. Hague. *Metallurgia*, **41,** No. 242, 63-67 (1949) Dec.

5.9, 6.2

Chemical Pickling of Iron and Its Alloys. J. Liger. *Galvano* (France), **17,** No. 151, 9-11 (1949) Aug. *J. Iron Steel Inst.*, **164,** No. 1, 111 (1950) Jan.

A discussion on the various alkaline and acid pickle liquors which can be used for pickling iron and its alloys.—ZDA.

5.9, 6.4

Alocrom: A New Pre-Treatment. *Light Metals*, **12,** No. 133, 71-77 (1949).

Describes a new low-cost chemical processing system for aluminum and its alloys which provides a basis for painting and improves resistance to abrasion and chemical attack. Operating conditions are detailed.—MA.

5.9, 6.3

Chemical Treatment of Die Castings Contributes to High Quality Organic Finishes. *Die Castings*, **8,** 45-48 (1950) June.

Treatments for zinc castings include conversion of the surface to a compound, phosphating, producing chromium salts on surface, chromating, etc. Discusses the merits of each. Describes briefly treatments for magnesium, copper, brass and lead castings. 18 references.—BLR.

5.9

Economical Degreasing with Emulsifiable Solvent Cleaners. *Electroplating*, 3, No. 6, 215-216 (1950).

The use of emulsion cleaners for the degreasing of metal surfaces before electroplating is discussed. Typical operational procedures, which include proprietary emulsion cleaners are given for cleaning steel and brass components.—MA.

5.9, 6.4

Modern Developments in Metal Finishing. *Electroplating*, **3,** No. 6, 208-211+; No. 7, 244-245+; No. 8, 287-291 (1950).

Reports on a series of lectures presented at the Northampton Polytechnic Institute, London. These include: Recent Developments in Electrodeposition Processes and Recent Developments in Plant for Electrodeposition by E. A. Ollard; Phosphate Treatments for Iron and Steel Surfaces by H. A. Holden; Methods for the Protection and Decoration of Aluminum by V. F. Henley; and Methods for the Protection of Magnesium Alloys by W. F. Higgins.—MA.

5.9

Rust and Stain Prevention with Water-Displacing Fluids. *Electroplating*, **3,** No. 7, 253 (1950).

A wide range of water-displacing fluids, available for the protection of metal surfaces which have been wetted by water, are based on an organic solvent, lanolin, and a surface-active material and a spreading agent. When the solvent evaporates a slightly tacky transparent film is left on the metal which prevents the rusting of cleaned and pickled steel. The film can be removed by degreasers when required.—RPI.

5.9

Rust Removal—New Brush or Immersion Treatment. *Chem. Age* (London), **62,** No. 1600, 388 (1950) Mar. 11.

The metal finishing division of the Pyrene Co., Ltd., Brentford, Middlesex, has introduced a general purpose and economical rust removing material with the trade name Preperite, which also can be used for the removal of corrosion products from aluminum and its alloys.

It can be used either as a brush-on material or made up for treatment of parts by immersion in a tank, where it will continue in service indefinitely by replenishment of the chemical. The solution can be used cold or heated to any temperature up to 140° F (60° C), the warmed solution having the advantage of speed. The immersion solution consists of one part Preperite and two parts water. An etch is left on aluminum surfaces after treatment, which is beneficial for paint bonding.—ALL.

5.9, 3.8

Contribution to the Knowledge of Electrolytic Polishing. R. Piontelli. *Met. Ital.*, **42**, No. 6, 205-224 (1950) June.

The theoretical treatment of the processes of electrolytic polishing is taken up again on general bases. The conceptions of the levelling power and microsmoothening power of the action of brightening or of etching with structural selectivity are introduced. The theories up to now proposed are discussed after a re-examination of the theories of electrolytic processes and of the phenomena of polarization. The conclusions are applied to the interpretation of the most characteristic aspects of the polishing processes.—MI.

5.9

Mechanism of Electropolishing. T. P. Hoar and J. A. S. Mowat. *Nature*, **165**, 64-65 (1950).

An hypothesis is formulated for the mechanism of electrolytic etching and polishing based on observations on nickel. The mechanism of electropolishing is shown to be similar in many respects to that of anodic passivation of nickel and other metals in concentrated sulfuric acid, both involving the initial formation of a compact oxide film. In the former case the film is dissolved with the rise of potential, remaining very thin and allowing the transport of nickel ions through it by diffusion. Under these conditions polishing, and not etching, occurs since dissolution is based on the random distribution of vacant sites in the oxide lattice. With a constant current density in a polishing bath, just large enough to produce polishing, violent oscillations of potential difference across the bath are observed which are of high frequency. This is explained in terms of the oxide-film theory. The corrosion properties of electropolished metals and the "smoothing-effect" in electropolishing are discussed in the light of this theory.—MA.

5.9

Continuous Pickling. J. H. Mort. *Iron and Steel*, **22**, No. 11, 479-85 (1949) Nov.

A theoretical discussion on the descaling of steel strip for hot-rolled coils. The author treats scale formation, mechanical detachment of scale, and pickling equipment before discussing the make-up of solutions and the relation between acid consumption and throughput.—ZDA.

5.9, 3.7, 6.3

On the Chemical Nature of Electrolytically Polished Surfaces and Its Practical Importance. Pierre A. Jacquet and Marcel Jean. *Compt, Rend.*, **230**, No. 21, 1862-1864 (1950).

According to H. Raether Copper electrolytically polished in orthophosphoric acid, although giving a diffraction diagram of a pure crystallized metal, behaved differently from copper deposited

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by evaporation in vacuo, which immediately oxidized in air as opposed to the 2-24 hr. required for the former to show any trace of oxygen. This could be accounted for by the presence of impurities other than oxide on the metal surface, due to one or more of the constituents of the anodic film formed during electrolysis. To test this hypothesis phosphorus was introduced into very pure copper, zinc and magnesium by a highly sensitive qualitative method to be described elsewhere, the metals being polished in orthophosphoric acid. Phosphorus and chromium were introduced on to iron polished in a mixture of phosphoric and chromic acids. The results showed that the surfaces of the copper, zinc and magnesium retain traces of a compound containing phosphorus. The iron does not retain any compounds rich in phosphorus or chromium, but is probably covered with oxide. These results are discussed from the point of view of certain particular properties of electrolytically polished metals, such as oxidation, corrosion, friction, electronic emission.—MA.

5.9, 3.2, 6.4

Mechanism of Electrolyte Oxidation and of Formation of Aluminum Oxide Layers. (In French.) *Rev. Aluminium,* **26,** 397-403 (1949) Dec.

Discusses mechanism of formation of the layer; describes experimental method for study of the phenomenon; and presents results of a study of two cases: formation of a very compact and highly insulating oxide layer; and formation of more or less porous layers of considerable thickness.—BLR.

5.9

Derusting and Rustproofing 20- and 44-mm Ammunition. U. S. Naval Ordnance Laboratory, PB. 31673, Frames 21; Board of Trade, Ger. Div., ORR. 78/50.

The report gives a description of a combined method of derusting and applying a protective phosphate coating. After this treatment the projectiles are coated with a lacquer, the formulation of which is given.—RPI.

5.9, 6.4

Concerning the Growth of Electrolytically Produced Porous Aluminum Oxide Films. (In German.) Heinz Wilsdorf. *Z. angewandte Physik,* **2,** 17-20 (1950) Jan.

The outer and inner-surfaces of the above films were examined under the electron microscope. Micrographs and tabulated data show the effects of acid and time on structure.—BLR.

5.9

Auxiliary Boiler Drains that Speed Up Chemical Cleaning. L. E. West. *Power,* **93,** 74-75 (1949) Jan.

If you clean steam generators and other heat-exchange equipment chemically, or are making plans to do it, this article lists some valuable aids that will expedite the job and cut outage time.—GPC.

5.9, 6.4

Anodic Oxidation of Metals With Different Surface Textures. (In Russian.) G. S. Vozdvizhenskii, A. Sh. Valeev and T. N. Grechukhina. *Doklady, Akademii Nauk SSSR, Reports of the Academy of Sciences of the USSR,* new ser., **72,** 311-313 (1950) May 11.

Influence of the surface condition of 99.5 percent aluminum following different surface treatments (abrasive-paper polishing, mechanical polishing, or electropolishing) on microstructure after anodic oxidation was investigated. Results are tabulated, illustrated, and discussed. Differences in porosity between sections parallel and perpendicular to the direction of working are described.—BLR.

5.9

Continuous Steel Strip Pickling. R. W. Treasure and Others. *J. Iron Steel Inst.,* **162,** Pt. 2, 201-212; **163,** Pt. 4, 449-452 (1949).—RPI.

5.9

Surface-Active Agents in the Improvement of the Cleaning of Metals. R. C. Tarring. Electrodepositors' Tech. Soc., Preprint No. 13, 8pp (1950).

The theory of surface-active agents is briefly considered. It is emphasized that in the cleaning of metals, only a comparatively small proportion of the cleaning solution is in actual contact with the metal at any one time and that, therefor, the actual relationship between the solution and the solid surface at the area of contact is a very important factor in the cleaning. The constitution of surface-active reagents is described and they are divided into three groups: anionic, cationic and non-ionic. The application of these substances to alkaline cleaning and to acid pickling is discussed. Brief reference is also made to their use in electrodeposition.—MA.

5.9

Laboratory Investigations on Metal Cleaning. S. Spring. *Met Fin.,* **48,** No. 3, 67-72 (1950) Mar.

Reports of photographic study of the mechanism of oil removal from steel in alkaline cleaning solutions, and discusses the factors influencing the process (surface roughness, oxide layer, oil composition, etc.).—RPI.

5.9

Cleaning of Metal Surfaces. G. Schultze. *Werkstoffe u. Korrosion,* **1,** No. 1, 26-33 (1950).

Schultze describes, in some detail, the composition and action of many solutions suitable for cleaning metal surfaces. The use of inhibitors is recommended. Mechanical methods of cleaning are mentioned. 18 references.—MA.

MATERIALS OF CONSTRUCTION

• Ferrous Metals and Alloys

6.2, 3.7

Welding of Corrosion- and Heat-Resisting Steels. J. A. McWilliam. *Welding,* **18,** 94-99 (1950) March; 150-156 (1950), Apr.

Weldability of a number of the above is discussed with reference to the particular techniques required. In the first part, the subject is treated from the metallurgical aspect; and in the second, processes suitable for fabrication with these steels are surveyed.—BLR.

6.2, 1.3

Stainless Steels—Their Selection and Application. T. C. DuMond. *Mat. & Meth.,* **31,** No. 5, 83-98 (1950) May.

Physical constants, mechanical properties, resistance to corrosion and to oxidation, methods of fabrication and uses of ferritic and austenitic stainless steels are clearly and simply summarized. Explanation of how they vary one from the other and conditions that govern their selection and application are given.—INCO.

6.2, 3.2, 3.5

Corrosion. Mars G. Fontana. *Ind. & Eng. Chem.,* **42,** 69A-70A (1950) Apr.

Oxidation behavior of 18-8S stainless steel at 1800° F in different oxidizing atmospheres obtained as a result of an ONR research program is charted and discussed.—BLR.

6.2, 1.7, 6.3, 3.5

Data on Corrosion- and Heat-Resistant Steels and Alloys—Wrought and Cast. R. Franks, Union Carbide & Carbon Corp.; J. W. Juppenlatz, Lebanon Steel Foundry; V. N. Krivobok, F. L. LaQue, Inco; E. A. Schoefer, Alloy Casting Inst. ASTM Comm. A-10 on Iron Chromium, Iron-Chromium-Nickel and Related Alloys. ASTM Spec. Tech. Publ. No. 52-A (1950) May.

All data are tabulated. Wrought chromium ferritic steels covers the 4-6 chromium, 8-10 chromium, 10-14 chromium, 14-18 chromium and 23-30 chromium steels. The wrought chromium-nickel steels covers 17 chromium-7 nickel, 18 chromium-8 nickel, 24 chromium-12 nickel, and 25 chromium-20 nickel steels. The cast corrosion-resistant alloys include 11-30 chromium and up to 4 nickel alloys and 18-30 chromium, 8-22 nickel alloys. The cast heat resistant alloys include straight chromium alloy with 26-30 chromium, 7 max. nickel, chromium-nickel alloys with 18-32 chromium, 8-22 nickel alloys (chromium always being in excess of nickel), and nickel-chromium alloys with 10-21 chromium, 33-68 nickel.—INCO.

6.2, 4.3

Stainless Steels; Improved Resistance to Sulphuric Acid. *Iron and Steel,* 23, 309-311 (1950) July.

Describes development of a steel resistant to sulfuric acid of any concentration at temperatures up to 40° C. Corrosion resistance of various stainless compositions to sulfuric acid is shown graphically for ranges of temperature and sulfuric acid strength. The alloy developed contains 18 per cent chromium, 18 per cent nickel, 2 per cent copper, and 2 per cent molybdenum.—BLR.

6.2, 4.3, 3.4

The Behavior of the Chromium Nickel Stainless Steels in Sulfuric Acid. George C. Kiefer and William G. Renshaw. *Corrosion,* **6,** 235-244 (1950) Aug.

Shows the corrosion rate of four commercial types and one special type of the above in sulfuric acid of varying concentration from 0 to 95 per cent at four temperatures. The effect of additions of various sulfates and oxidizing agents is also shown.—BLR.

6.2, 3.7, 3.4, 3.2, 5.1, 3.5, 4.2, 4.3, 4.4, 4.6

The Corrosion of the Austenitic Stainless Steels. Parts I-IV. G. T. Colegate. *Metallurgia,* **41,** 147-150, 259-262, 305-308, No. 247, 362-366 (1950) Jan., Mar., Apr., May.

I. Discusses effect of alloying elements in addition to chromium and nickel and of corrosive media with which the material may come into contact in service. II. Discusses pitting and intergranular

corrosion, including mechanisms involved, effects of alloying additions, and preventive methods. III. Effects of stress corrosion, modified compositions, and atmospheric exposure are reviewed. IV. Behavior of stainless steels when subjected to attack by various liquids and gases is discussed. The groups of substances to be considered include acids, alkalies, salt, food products, natural waters, non-aqueous liquids and gases.

6.2, 3.5

Mechanism of the Rapid Oxidation of High Temperature, High Strength Alloys Containing Molybdenum. W. C. Leslie and M. G. Fontana. *Trans. ASM*, 41, 1213-1247 (1949).—MI.

6.2, 1.7, 5.3, 5.4

The Protection of Steel and Iron Surfaces Against Corrosion. J. C. Hudson. *Met. Ital.*, **42**, No. 3, 85-94 (1950) Mar.

A report, presented at the Third National Meeting of the Associazone Italiana di Metallurgia, on the work of the Protective Coating Sub-Committee of the British Iron and Steel Research Association over the past 20 years. The research has covered paints and metallic coatings and the effects of various methods of surface preparation. A graph shows the results of long term tests on zinc coatings at Sheffield over a period of eight years. The weight of zinc per square foot of surface is still seen to be the most important factor in determining the life of a zinc coating at a particular site.—ZDA.

6.2, 3.6, 4.6

Corrosion of Ferrous Metals. G. W. Lain. *Steel*, **126**, No. 11, 101-104 (1950) Mar. 13.

A discussion on the factors involved in the corrosion of ferrous metals, with emphasis on the need for considering each case individually. The various main classes of corrosion are briefly described, and considerable space is devoted to describing the effect of occasionally reversing the potential between steel and zinc. The results of recent research are quoted extensively, and illustrated by graphs. The composition of the water, as well as its temperature, plays an important part, sulfates and chlorides tending to prevent reversal, nitrates and bicarbonates promoting it. Reversal has not been observed in the absence of oxygen.—ZDA.

6.2, 8.8

How to Choose a Stainless Steel. L. Guitton. *Metaux & Corrosion*, **25**, No. 296, 91-99 (1950).

Stainless steels are classified into groups and their characteristics and applications in the chemical industry are discussed.—EP.

6.2

Stainless Steel—Its Development and Use. V. W. Whitmer, Republic Steel Corp. *Iron Steel Engr.*, **27**, No. 11, 70-73 (1950) Mar.

The growth of the stainless steel industry, its properties of corrosion resistance and heat resistance are discussed. The type of stainless steel used in various industries is described.—INCO.

6.2

Nodular Gray Iron Compared With Other Cast Ferrous Metals. G. Vennerholm, H. Bogart and R. Melmoth. *Mat. & Meth.*, **31**, No. 4, 51-55 (1950) Apr.

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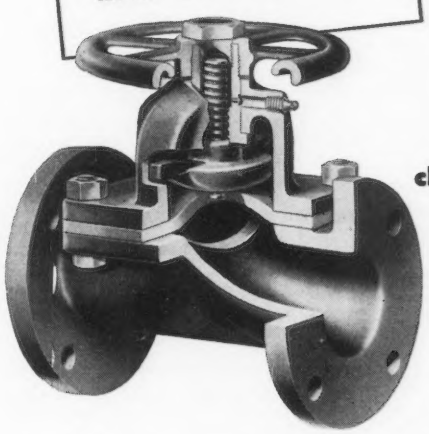

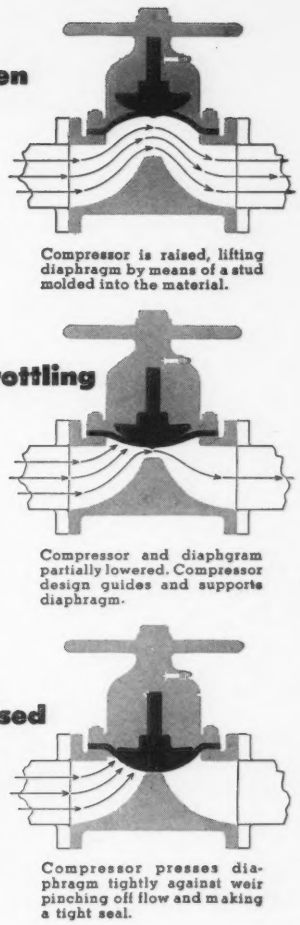
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development that has aroused considerable interest during the past several years. This article evaluates the present status of nodular cast iron as an engineering material. It deals in particular with nodular iron produced by using magnesium-copper-ferrosilicon alloys. Mechanical properties, casting properties, machinability, heat-treatments and cost of production are covered. Finally, the article arrives at some conclusions concerning the place nodular iron has in relation to ordinary gray irons, malleable irons and steel castings.—TDD.

6.2, 3.2

Extra Low Carbon Stainless Steel. Arba Thomas. *Corrosion* (News Section) **6,** No. 1, (1950) May.

Points out tendency of austenitic stainless steels to intergranular corrosion adjacent to welds. This inherent weakness can be solved by the use of columbium or titanium stabilized grades, but cost is greatly increased. Recommends use of extra-low-carbon Types 304 and 316. It was found that when the carbon content was reduced to 0.03 percent max., no harmful carbides were precipitated at grain boundaries in the parent metal adjacent to the weld. This resulted in elimination of localized intergranular attack or weld decay adjacent to welds in severely corrosive environments.—BLR.

6.2

Aluminum Decreases Corrosion Resistance of Austenitic Stainless. R. W. Stewart and S. F. Urban. *Iron Age,* **166,** 91-95 (1950) Aug. 17.

Shows that presence of sigma phase, rather than chromium carbide precipitation, is responsible for the low corrosion resistance of titanium-stabilized austenitic stainless steels in boiling 65 percent nitric acid, when tested after sensitizing treatment. The quantity of sigma can be minimized by rather close control of aluminum, chromium and nickel contents. Graphs, tables, and photomicrographs.—BLR.

• Non-Ferrous Metals and Alloys—Heavy

6.3

Some Properties of Tantalum-Rich Alloys with Tungsten and Molybdenum. Rupert H. Myers. *Metallurgia,* **42,** No. 248, 3-9 (1950).

A study of the tantalum-rich alloys with tungsten and molybdenum has shown that the addition of >10 atomic percent of tungsten or molybdenum makes tantalum very difficult to work at room temperature; heating at 500° C does not improve the workability. The ultimate tensile strength, hardness, resistivity, and work-hardening rate are increased and the elongation decreased by the addition of tungsten and molybdenum, equal atomic additions of both causing the same order of changes, although molybdenum has a much greater effect on resistivity. Resistance to oxidation of the alloys is no better than that of tantalum, and the alloys are susceptible to gas-hardening at elevated temperature, as is tantalum. Small additions of tungsten and molybdenum strengthen tantalum without destroying its cold workability, and the alloys are not brittle in the annealed condition.—MA.

6.3, 4.3

Titanium: Good But Not Miraculous. E. C. Fetter. *Chem. Eng.,* **57,** No. 5, 263-264 (1950) May.

The corrosion resistance of titanium and stainless steel are compared in respect to sulfuric acid, hydrofluoric acid, nitric acid, hydrochloric acid, chlorine, chloride salts, phosphoric acid, sodium hydroxide. The corrosion resistance of the two is the same, with the exception that titanium is superior in resistance to solutions of chlorine, chlorides and dilute hydrochloric acid. If the price of titanium gets down to match that of stainless steel, it will give stainless steel competition because of its lighter weight and higher strength. Charts.—INCO.

6.3, 3.5, 3.6, 3.7

Copper-Base Alloys for Springs, I-II. Harold C. R. Carlson. *Prod. Eng.,* **20,** No. 2, 103-107; No. 3, 86-91 (1949).

I. The corrosion, galvanic corrosion and stress-corrosion properties of spring brass, phosphor bronze and beryllium-copper are discussed. The gauges and tempers in which these alloys are available are described. Workability and methods for joining these alloys (i.e. welding, brazing, and soldering) are also discussed. II. The mechanical properties and applications of 70 : 30 brass, phosphor bronze and beryllium-copper are described. The effects of cold work and heat-treatment are discussed. Brief mention is made of copper-manganese alloy, nickel silver, silicon bronze, aluminum bronze and tin brasses as spring materials.—MA.

6.3, 3.5, 3.2

High Temperature Scaling of Cobalt. R. J. Charley and W. M. Baldwin. *J. Metals,* **1,** No. 10, 720-721—MI.

6.3, 4.4

Corrosion of Metals (Zinc, Copper) by Organic Liquids. R. Dubrisay. *Rev. Industr. Text Belg.,* **13,** No. 33, 13 (1949); *Brit. Abs.* BI, 937 (1949) Dec.

A brief discussion on the interaction of zinc and copper with carbon tetrachloride in the presence of water.—ZDA.

6.3, 3.7

Defects Encountered in "Horological" Quality Brass. (In French.) J. Herenguel. *Rev. Met.,* **47,** No. 6, 455-464 (1950) June.

An investigation on brass and leaded 60/40 brass (strip and bar) used in clock-making established that the main defects are: uneven surface on a macro- or micro-scale, due to rough or crooked rolls; coarse grain and preferred orientation; casting flaws, including pores and segregated lead, causing tears in strip; cracks arising during drawing of bars; surface stains on strip (various causes). Hints for avoiding these defects are given.—BNF.

6.3, 3.4, 3.5

Corrosion of Copper by Trace Constituents of Natural Gas. H. O. Kruger and M. L. Robinson. *Gas,* **26,** No. 4, 31-35 (1950) Apr.

The corrosiveness of low concentrations of hydrogen sulfide and methyl mercaptan in natural gas and the extent of copper corrosion in the field were determined. The high temperature oxidation of copper is accelerated by such gases as hydrogen sulfide, hydrogen chloride, sulfur dioxide and ammonia. These gases even promote oxidation at room temperature. The presence of a sulfide film on a copper surface promotes oxidation even at room temperature, but at room temperature an oxide film reduces further oxidation with hydrogen sulfide. Field experience confirms the corrosivity of low concentrations of hydrogen sulfide at atmospheric temperature.

6.3, 3.4, 3.5, 2.3

The Intermittent Oxidation of Some Nickel-Chromium Base Alloys. B. Lustman, Westinghouse Elec. Corp. *J. Metals,* **188,** No. 8, 995-996 (1950) Aug.

Certain features of oxidation were revealed that may clarify the mechanism of protection conferred by rare-earth and alkaline-earth elements to the nickel-chromium base electric-resistance alloys. These features occurred in the development of a test for the resistance to oxidation of alloys in massive form under conditions of intermittent heating and cooling. They include weight changes of the specimen, X-ray diffraction results, ASTM life tests, and microstructure studies. The experimental data indicates that the improvement in the oxidation behavior of nickel-chromium base electric-resistance alloys (by addition of small amounts of certain elements) is achieved through the tendency of the added elements to promote internal oxidation. This internal oxidation is promoted during cycles of heating and cooling.—TDD.

6.3, 3.4, 3.5

Oxidation of Molybdenum in Air at 1100° to 1600° F. B. Lustman. *Metal Prog.,* **57,** 629-630, 67+ (1950) May.

Describes fundamental principles and actual behavior of molybdenum and its oxides at above temperatures in air. Presents experimental data on oxide production on heating for various times and at different temperatures. Amount of oxide which was strongly adherent was also determined. Indicates principles that will lead to a molybdenum-base alloy with a nonvolatile, impervious refractory and protective scale.—BLR.

6.3

Chromium—Key Metal for Strength, Corrosion Resistance and Heat Resistance. *Iron Age,* **165,** No. 1, 303 (1950) Jan. 5.—MI.

6.3, 5.9

Cleaning Zinc and Zinc Alloys. *Galvano* (France), **19,** No. 158, 10 (1950) Mar.

Two formulae are given for solutions in which a zinc surface can be quickly brightened. One uses a mixture of chromic acid and sodium sulfate, and the other a mixture of chromic and hydrochloric acids. Sometimes preliminary degreasing is necessary.—ZDA.

6.3, 4.3

High-Nickel Alloys versus Sulphuric Acid. *Indust. Chemist,* **26,** No. 303, 155-159 (1950). Condensed from Publication by Henry Wiggin and Co., Ltd.

The results are given of various experiments on the corrosion of the following nickel-containing alloys by sulfuric acid: nickel (99.4%), K Monel, H Monel, S Monel, Inconel, and Ni-Resist cast iron. The tests included a) tests of the corrosion in boiling sulfuric acid solutions (5-96%) for times up to 23 hours, b) tests of the corrosion of Monel by air-saturated solutions con-

taining up to 2.5% sulfuric acid, c) experiments on the effect of arsenic on the corrosion of Monel by 71% acid, d) galvanic corrosion tests of Monel/chemical lead couples in 6% acid, e) tests of the corrosion of nickel in up to 38% acid at room temperature, f) tests of the corrosion of Inconel in up to 93% acid at various temperatures, and g) tests of the corrosion of Inconel, nickel, and Monel pressure vessels by liquid sulfur trioxide. The effects of the presence of oxidizing salts in the solution and of the solution velocity were investigated in some of the experiments. The applications of the materials investigated in the construction of plant handling sulfuric acid are discussed. The results obtained show that the order of merit of the different alloys varies markedly with the strength, temperature, etc., of the acid.—MA.

6.3, 3.7

Titanium. *Prod. Eng.*, **20,** No. 11, 129-152 (1949).

The production of titanium by powder metallurgy, induction melting and arc melting is described. Mechanical, physical and chemical properties of titanium are given and methods of fabrication, viz. machining, forging, welding, extrusion, casting, bending and forming, heat-treatment and swaging are discussed. The effect of alloying elements on the mechanical properties of titanium is also considered.—MA.

6.3, 4.3, 4.4

Materials Engineering File Facts—Corrosion Resistance of Titanium Metal in a Number of Chemical Reagents. *Mat. & Meth.*, **32,** No. 1, 75 (1950) July.

Table of effects of chemical reagents. Includes organic and inorganic acids, and other well known chemicals.—INCO.

6.3, 1.3

Titanium. H. O. Nicolaus. *Z. V. d. I.*, **92,** No. 7, 153-160 (1950).

A review, with 75 references.—MA.

6.3, 8.8, 4.3

Lead as a Construction Material in Chemical Processes. F. S. McCarthy, Canadian Ind. Ltd. Paper before Can. Metal Co., Montreal District Sales Organiz., Jan. 5, 1949. *Can. Chem. Process Inds.*, **34,** No. 6, 474-477 (1950) June.

Lead is resistant to sulfuric acid corrosion at concentrations up to 96 percent at room temperature and to concentrations up to 85 percent at 425° F. At strengths above 85 percent cast iron and steel have substantial resistance and are used instead. Duriron shows resistance to all concentrations of pure sulfuric acid up to and including boiling temperatures. Monel may be used in unaerated solutions in concentrations up to 85 percent at room temperature, up to 60 percent at 200° F and up to 15 percent at boiling temperatures. It is less resistant than lead or Duriron but is used because of its good physical properties. Both Inconel and nickel are less useful than Monel and are used only under special conditions. Stainless steel is used at low concentrations and/or temperatures of the acid. Durimet 20 a high nickel-chromium alloy, shows negligible corrosion in all concentrations at room temperature and may be used up to 65 percent concentrations at 175° F. Wet sulfur dioxide can be handled by Type 316 stainless steel or by Hastelloy. Stainless steel, Duriron and lead may

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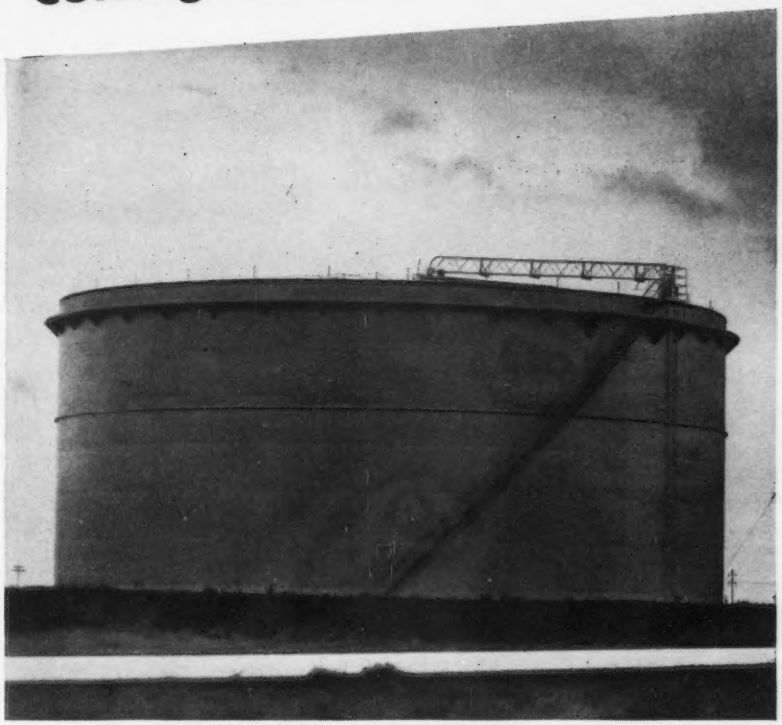

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be used in phosphoric acid manufacture only in the absence of fluorides. Stainless steel and aluminum are used for nitric acid manufacture.—INCO.

6.3

Preliminary Research on Wrought Aluminum Bronzes Containing Beryllium. (In Italian). C. Panseri. *Alluminio*, **19**, No. 1, 9-17 (1950).

Presents results of experiments on nine new compositions of the above. On the basis of micrographic and tensile tests, it appears that alloys containing 4.5-5 percent aluminum, 0.9-1.1 percent beryllium, copper, remainder; and 6.5-7.0 percent aluminum, 0.3-0.4 percent beryllium, copper remainder are promising. As additional elements, nickel and silver are of principal importance. Corrosion resistance and workability were also evaluated. Numerous micrographs, tables and graphs. 10 ref.—BLR.

6.3, 3.5

More Zirconium Coming Up! *Steel*, **127**, 63-64+ (1950) July 24.

Presents flowsheet for continuous process developed by Bureau of Mines for reducing anhydrous zirconium chloride with magnesium under helium. Discusses present and potential uses (fluorescent lights, steel desulfurizer and deoxidizer, cast-iron-graphite nodulizing agent, etc.) Heat resistance in various atmospheres is described.—BLR.

6.3, 4.3

Monel and Some Other High-Nickel Alloys versus Sulphuric Acid. Henry Wiggin & Co., Ltd. Brochure, 1950, 71 pp. Obtainable from the Company, Wiggin Street, Birmingham, 16, England.

Deals with Monel (including 'K,' 'H' and 'S'; types), nickel, Inconel, nickel-chromium, nickel-chromium-iron, and Ni-Resist, giving much useful information. Section I describes their behavior in sulfuric acid, and the effect of concentration, temperature, aeration or presence of oxidizing salts, velocity, impurities, galvanic action, stress, etc., on the corrosion resistance. Tests in liquid sulfur dioxide and oleum are also reported. Section II presents results obtained in particular applications: pickling of iron, steel, brass or copper; organic sulphations and sulphonations; soap making; petroleum refining; esterifications and condensations; treatment of tar oils; production of ammonium sulfate, aluminum sulfate and other sulphates; dyeing, rayon spinning, etc.—BNF.

6.3, 1.3

Copper and Copper Alloys: Technical Progress in 1949. E. Voce. *Metallurgia*, **41**, Nos. 242 and 243, 96-101, 150-152 (1949) Dec. (1950) Jan.

Review based on 107 references, covering ore reserves, extraction, melting and casting, fabrication, finishing and plating, properties, joining, corrosion, physical metallurgy, secondary metals and clock and instrument manufacture.—BNF.

• Non-Ferrous Metals and Alloys—Light

6.4, 5.9

Magnesium Processing and Finishing. Gilbert C. Close. *Prod. Fin.*, **14**, No. 7, 32-34+ (1950).

Preliminary cleaning methods are briefly described. For removing graphite lubricant used in deep drawing immersion for ½-2 minutes in 15-20% chromic acid solution is recommended. Hot chemical dips containing dichromates are referred to, but where abrasion-resistance is required in addition to corrosion-resistance, an anodizing treatment in saturated sodium carbonate solution at 198°-210° F (92°-99° C) is advocated. A voltage of 115 is used, giving an initial c.d. of about 100 amp/ft² which rapidly falls off as the surface becomes coated with magnesium carbonate until at the end of the treatment it is only about 0-15 amp/ft.² This process is effective in treating most magnesium alloys. The corrosion-resistance of the coating is superior to coatings formed in dichromate baths, especially in sea-water and marine atmospheres. Brief details are included on actual corrosion trials. A solution containing 5-20% chromium trioxide is recommended for removing corrosion product from magnesium which has been attacked slightly in store. The actual concentration used depends on the amount of corrosion product present. In cases where the deposit is heavy the solution may be used up to 95° F (35° C). It is made up with distilled water. A few experiments have been made using a similar solution anodically to remove corrosion product.—MA.

6.4, 3.5, 3.2, 3.8

The Oxidation of Beryllium at High Temperatures. Daniel Cubicciotti. *J. ACS*, **72**, No. 5, 2084-2086 (1950).

A study of the rate of reaction between beryllium metal and oxygen gas from 840° to 970° C shows that oxidation proceeds according to the parabolic law, with much smaller rate constants than for other similar reactions (e.g. the oxidation of aluminum or 50 : 50 chromium-nickel alloy). The energy of activation for the oxidation of beryllium was found to be 62 kg. cal/mole.—MA.

6.4, 8.4

Aluminum Alloys in Petroleum Equipment. W. M. Doyle. *Petro. Times*, **54**, 320-323 (1950) May 5.

Properties of various cast and wrought Hiduminium alloys, and application in the oil industry: drilling rigs, wheels, pipelines, storage tanks, oil tanker bulkheads, buildings, mosquito screens, bubble caps and trays for distillation columns, equipment for sub-zero temperatures, heat exchangers, road and rail tank cars for distribution of fuel and synthetic detergents, etc.—BNF.

6.4, 1.3, 4.3, 4.4

Use of Aluminum (and Alloys) in the Chemical Industry. G. A. Dummett. Soc. Chem. Ind., Conference on Materials of Construction in the Chemical Industry, 135-141, 1950, April.

A survey of the behavior of aluminum towards corrosive influences; protection, alloys, fabrication; uses in connection with nitric acid, hydrogen peroxide, fermentation, formaldehyde, varnish, vegetable oils, acetic acid; heat exchangers. Much useful information is collected together.—BNF.

6.4, 5.9, 5.4

Protection of Magnesium Alloys. E. E. Halls. *Electroplating*, **3**, No. 9, 339-346 (1950) May.

Results are tabulated for the resistance to mild humidity, salt spray, and open atmospheric exposure tests of sheet and cast magnesium-base alloys with and without various combinations of organic coatings and with and without chromate pretreatment. Both mild and vigorous chromate pretreatments were examined with no conclusive evidence for the relative superiority of either for protection against corrosion. Chemical pretreatments are essential for protection of magnesium alloys and the chromate type of process is very satisfactory. The nature of the primer or first coating material is very important and certain iron oxide and chromate-base primers are of exceptional value. The zinc chromate primers are outstanding in this direction and can perform the role of chromate pretreatment as well as fulfilling their own function as first coating medium. Phosphating processes show merit and justify further work, particularly in the direction of combined phosphate-chromate processing. Charts.—INCO.

6.4, 1.3, 5.3, 4.1

The Corrosion and Protection of Magnesium Alloys. Norman Bryce Harvey. *J. B'ham. Met. Soc.*, **30**, No. 1, 26-40 (1950). A prize-winning essay.

The author commences his review of published information by discussing the mechanism of the corrosion of magnesium, and considers the influence of impurities, the effects of specific chemicals, the resistance to corrosion by the atmosphere and stress-corrosion resistance. Methods of testing the susceptibility of magnesium alloys to corrosion are briefly described. The protection of magnesium alloys by a) cladding, b) metal spraying, and c) chemical dipping and anodizing methods is briefly discussed. 15 references.—MA.

6.4, 3.5, 3.7

Stress-Corrosion of Aluminum 7% Magnesium Alloy. E. C. W. Perryman and S. E. Hadden. *J. Inst. Metals*, **77**, 207-235 (1950) May.

Above properties were determined after various aging treatments. Shows that there is close correlation between continuity of the grain-boundry β precipitate and the stress-corrosion susceptibility when sprayed with 3 percent sodium chloride solution, maximum susceptibility occurring when this precipitate is apparently quite continuous. Cold work before aging increases rate of precipitation and has a profound effect on stress-corrosion susceptibility. Internal strains set up during precipitation are shown to play no important part in the stress-corrosion mechanism. Small additions of zinc decrease rate of precipitation; however, they have little or no influence on stress-corrosion susceptibility. Tables, graphs, and photomicrographs. 26 ref.—BLR.

6.4

New Aluminum-Zinc-Magnesium-Copper Casting Alloys. W. E. Sicha and H. Y. Hunsicker. American Foundrymen's Society, Preprint No. 50-14, 9 pages (1950).

Investigations of the above have led to two new compositions, A612 (6.5 percent zinc, 0.7 percent magnesium, 0.5 percent copper, 0.15 percent titanium) for sandcasting and C612 (6.5 percent zinc, 1.0 percent iron, 0.5 percent copper, 0.35 percent manganese, 0.10 percent titanium) for permanent-mold casting. Discusses mechanical properties; aging, brazing and casting characteristics; and resistance to corrosion and stress-corrosion cracking. Data are tabulated and plotted. —BLR.

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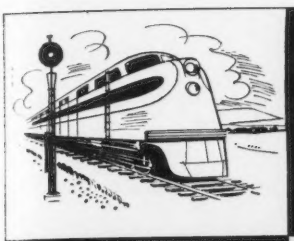

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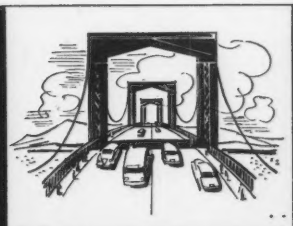

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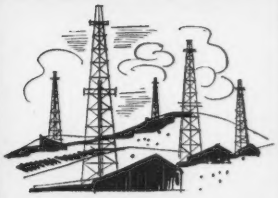

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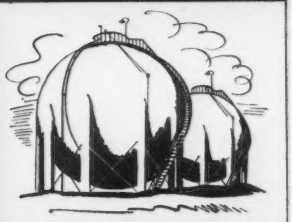

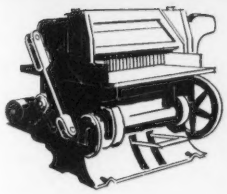

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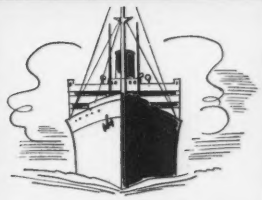

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6.4, 2.3

Corrosion and Stress Corrosion Properties of a High Strength Aluminum-Zinc-Magnesium-Copper Casting Alloy. R. A. Quadt and E. C. Reichard. American Foundrymen's Society Preprint No. 54-47, 1950.

Immersion tests and stress corrosion tests were carried out on a self-ageing, sand-cast aluminum alloy containing 7.5 zinc, 0.8 copper and 0.4 percent magnesium in 3 percent aerated sodium chloride solution. The alloy showed equivalent resistance to attack as compared to the aluminum-5 percent silicon composition usually used where good corrosion resistance is required. The specimens simultaneously corroded and stressed were unaffected by loads up to 80 percent of the yield strength. Stress corrosion cracking occurs beyond a threshold value located between 80 and 90 percent of the specimen yield strength. Some of the specimens subjected to corrosion and stressed as high as 24,000 psi showed no loss in tensile properties.—ALL.

6.4, 3.7

On the Influence of Zirconium on the Solidification Crystallization of Magnesium Alloys, and Some Properties of Cast Magnesium Alloys Containing Zirconium. F. Sauerwald. *Z. Metallkunde* (Germany) **40,** No. 2, 41-46 (1949). *Met. Abs,* England. **17,** Part 5, 338 (1950) Jan.

A study was made of the influence of additions of 0.1-1.1 percent zirconium on the properties of magnesium and its alloys. When 0.6 percent zirconium is added to molten magnesium it exercises a most intensive grain-refining effect on solidification, the zirconium particles acting as additional nuclei for crystal formation. Consequential effects are improved mechanical properties pressure-tightness, and corrosion-resistance. Such additions increase the 0.2 percent proof stress from 5.2 to 6.2 kg per sq mm (11 kg per sq mm after solution treatment), the tensile strength from 16.7 to 17.4 kg per sq mm (20 kg per sq mm after solution treatment), and elongation from 16.9 to 22 percent; microporosity is completely absent. Similar effects are produced by the addition of 0.6 percent zirconium to binary alloys of magnesium with zinc, cadmium, cerium, potassium, thorium, silver, copper, bismuth, thallium, lead, or beryllium.—ALL.

6.4, 5.9

Surface Layers on Magnesium. (In German). F. Sauerwald. *Z. anorg. Chem.,* **262,** 69-78 (1950) May.

Magnesium alloys were anodized in salt baths and in aqueous solutions of the same salts in order to study the corrosion properties of the resulting surface films. Data are graphed and tabulated. —BLR.

6.4, 3.7

Rolled Magnesium-Zirconium Alloys. (In German.) Franz Sauerwald. *Z. Metallkunde,* **41,** 81-87 (1950) Mar.

Shows that magnesium alloys, whose cast grain size has been reduced by refining with zirconium, has especially good plastic properties and is well suited for rolling, especially rolling directly as-cast without preliminary extrusion. Binary and polynary alloys have good corrosion resistance and mechanical properties. Data are graphed and tabulated.—BLR.

6.4, 4.2

Do Atmospheric Conditions Affect Magnesium? *Magazine of Magnesium,* 1950 Aug., 2-5.

A wide variety of applications of magnesium which demonstrate its resistance to corrosion by atmospheres are described and illustrated by photographs. These applications include trays, tools, ladders, tables, conveyors, dockboards, loading ramps, handtrucks, bakery delivery boxes and cabinets, textile equipment, foundry flasks, garden hose hangers, number plates and aircraft wings. Atmospheric exposure tests at Point Judith, R. I., and Kure Beach, N. C., show that marine atmospheres cause little or no corrosion of magnesium. However, proper insulation from dissimilar metals should always be provided to prevent galvanic corrosion. Under certain service conditions a protective coating for magnesium may be desirable, but bare magnesium gives satisfactory service when exposed to atmospheres.—ALL.

6.4, 5.9

Finishing Magnesium. *Prod. Fin.* (London) **3,** No. 3, 74-85+ (1950) Mar.

Corrosion; lists of compounds recommended and not recommended for contact with magnesium; cleaning, protective treatments and polishing of various magnesium alloys.—BNF.

6.4

New Aluminum Alloy Offers High As-Cast Properties. *Mat. & Meth.,* **31,** 61-62 (1950) June.

Describes physical and mechanical properties of "Almag 35." Use of high-purity aluminum results in a corrosion-resistant casting alloy with exceptional strength, ductility, and machinability without need for heat treatment.—BLR.

6.4, 3.5, 3.7

Relationship Between the Ageing and Stress-Corrosion Properties of Aluminum-Zinc Alloys. E. C. W. Perryman and J. C. Blade. *J. Inst. Metals,* **77,** 263-286 (1950) May.

Changes in microstructure which take place on ageing an aluminum + 10 percent zinc alloy at room temperature and at temperatures up to 125 degrees C were investigated and results correlated with stress-corrosion properties. Alloys containing 8 and 13 percent zinc were also examined. Tables and photomicrographs. 21 ref.—BLR.

6.4

Aluminum: Its Surface Preparation and Finishing. III. Paint Finishes. E. R. Yarham. *Prod. Fin.,* **14,** No. 4, 36+ (1950). Condensed from *Aluminum Develop. Assoc. Inform. Bull.,* **13,** 43 pp. (1947). —MA.

6.4, 8.4

Petroleum — Foremost Material of Modern Chemistry (Le petrole-matiere premiere de la chimie moderne). M. Victor. *Rev. Aluminium* (France) **27,** No. 165, 144-151 (1950) Apr.

The plant of the British company Petrochemicals Ltd. at Parrington, England, transforms compounds resulting from the distillation of crude oil into over fifty new products used in organic chemistry and synthetic materials by the Catarole process. This new process with its complicated equipment which includes catalysis cracking cells and installations for distillation under various pressures and very low temperatures has led to an extensive use of aluminum. The corrosion resistance of aluminum to petroleum, nitric acid, fatty acids and industrial waters and atmospheres has been an important factor in its being chosen as a construction material. Sheet aluminum is used extensively as a protection for thermal insulation of conduit and distillation towers. It also finds extensive use in condenser tubes, reaction tanks, filter presses, platforms and other structural assemblies, condensation collectors, instrument cases, control panels and other equipment.—ALL.

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